LIBRARY
APR 23 1942
DARTMOUTH COLLEGE

Vol. 19, No. 4 APRIL, 1942

AMERICAN JOURNAL OF OPTOMETRY *and* ARCHIVES *of* AMERICAN ACADEMY OF OPTOMETRY

EDITORIAL COUNCIL

R. J. BEITEL, JR.
HOWARD C. DOANE
GLENN A. FRY
A. P. WHEELOCK
J. FRED ANDREAE
G. O. OHLSSON
D. R. PAINE
E. LEROY RYER

ASSOCIATE EDITORIAL REFEREES

R. E. BANNON
BRANT CLARK
M. THOMA EBERL
WM. FEINBLOOM
RICHARD M. HALL
E. E. HOTALING
D. G. HUMMEL
O. J. MELVIN
FRANK K. MOSS
J. NEUMUELLER
E. PETRY
CHARLES SHEARD

EDITORS

CAREL C. KOCH

GUY L. DUPLESSIS
CLARENCE W. MORRIS

COLLABORATORS

A. N. ABBOTT, *Shawano, Wis.*
E. ALLGAIER, *Washington, D. C.*
F. L. AVERA, *Los Angeles, Calif.*
J. O. BAXTER, JR., *New Bern, N. C.*
J. O. BAXTER, SR., *New Bern, N. C.*
R. C. BAXTER, JR., *Warren, Ohio*
R. T. BEST, *Fairmont, Minn.*
F. W. BROCK, *Staten Island, N.Y.C.*
W. I. BROWN, *New Bedford, Mass.*
J. ROBINSON COHEN, *New York, N.Y.*
J. H. DRAKEFORD, *New York, N. Y.*
ISRAEL DVORINE, *Baltimore. Md.*
T. H. EAMES, *Arlington Center, Mass.*
R. H. EHRENBERG, *Granite Falls, Minn.*
V. ELLERBROCK, *Columbus, Ohio*
T. A. W. ELMGREN, *Columbia, S. C.*
A. B. EMMES, *International Falls, Minn.*
WARD H. EWALT, JR., *Pittsburgh, Pa.*
W. S. FARMER, *Oklahoma City, Okla.*
H. M. FISHER, *New York, N. Y.*
L. P. FOLSOM, *South Royalton, Vt.*
H. L. FOUG, *Los Angeles, Calif.*
H. K. FULKERSON, *Somerset, Ky.*
M. FURMAN, *New York, N. Y.*
W. GASSON, *Watford Herts, Eng.*
W. H. GLAZER, *Philadelphia, Pa.*
J. G. GOODSELL, *Los Angeles, Calif.*
P. B. GOSS, *Philadelphia, Pa.*
N. GREEMAN, *San Antonio, Texas*
R. GREENSPOON, *Beverly Hills, Calif.*
W. GREENSPOON, *Bluefield, W. Va.*
H. GRUMAN, *Lebanon, Pa.*
HOWARD F. HAINES, *Columbus, Ohio*
W. J. HEATHER, *Southbridge, Mass.*
E. A. HUTCHINSON, *Los Angeles, Cal.*
O. H. JOHNSON, *Jonesboro, Ark.*
J. CLAIRE KEHOE, *Flint, Mich.*
L. H. KRASKIN, *Washington, D. C.*
E. W. LARSON, *Hibbing, Minn.*
A. R. LAUER, *Ames, Iowa*
C. J. LOOSER, *Lodi, Calif.*
M. LUCKIESH, *Cleveland, Ohio*
G. A. MACELREE, JR., *Philadelphia, Pa.*
A. H. MALIN, *Philadelphia, Pa.*
H. B. MARTON, *Manchester, Eng.*
D. J. MAYER, *Riverside, Calif.*
W. A. MEYER, *Sacramento, Calif.*
LEO J. MILLER, *Lincoln, Nebr.*
H. MOLISH, *Columbus, Ohio*
RAY MORSE-PECKHAM, *Detroit, Mich.*
H. G. MOTE, *Columbus, Ohio*
JOHN C. NEILL, *Philadelphia, Pa.*
C. R. PADELFORD, *Fall River, Mass.*
G. A. PARKINS, *Ord, Nebr.*
J. I. PASCAL, *New York, N. Y.*
HARRY E. PINE, *Chicago, Ill.*
H. S. PLAYER, *Stockton, Calif.*
E. E. REESE, *Westerville, Ohio*
A. R. REINKE, *Oakland, Calif.*
EARL R. RIDGEWAY, *Trenton, N. J.*
S. H. ROBINSON, *Prescott, Ariz.*
CHARLES I. SAKS, *Syracuse, N. Y.*
S. H. SHURIN, *Kansas City, Mo.*
R. SIMPSON, *Pasadena, Calif.*
S. W. SMITH, *Philadelphia, Pa.*
WILLIAM SMITH, *Boston, Mass.*
M. STEINFELD, *Paducah, Ky.*
K. B. STODDARD, *Berkeley, Calif.*
W. J. TAIT, *Philadelphia, Pa.*
S. A. TITUS, *Kansas City, Mo.*
R. N. WALKER, *Winston-Salem, N. C.*
NEILL WARREN, *Los Angeles, Calif.*
E. G. WISEMAN, *Buffalo, N. Y.*
ARENE T. WRAY, *Los Angeles, Calif.*
NORMAN Z. ZEVIN, *Lehighton, Pa.*

Published Monthly by the AMERICAN JOURNAL OF OPTOMETRY PUBLISHING ASSOCIATION.
1501 Foshay Tower, 821 Marquette Ave., Minneapolis, Minn.

ANNUAL SUBSCRIPTION $4.00 CANADA $4.50, FOREIGN $5.00
Single copies, 50c

Entered as second-class matter February 20, 1924, at the postoffice at Minneapolis, Minnesota. under the Act of March 3, 1879.

KONOPTIC

WINGERS

"IN TUNE WITH THE TIMES"

Styled by Kono

- **Wingers are styled for smartness and built for comfort without sacrifice of optical perfection. Definitely new in design Wingers follow the natural facial lines, incorporating in the unique eye shape a greater field of vision and a minimum of rim interference.**

  Wingers are quickly accepted by discriminating buyers seeking a zylo frame that is fashionable without being spectacular.

  And remember! Wingers are *hand crafted Konoptics*, your assurance of perfection in quality and workmanship.

Please order thru your jobber

Wingers No. 1
(*Low Ful-vue*)
English hinges and shields with skullfit paddle temples.

Wingers No. 2
Illustrated
(*Low Ful-vue*)
Inlaid hinges and shields with Jr. Hollywood temples.

U. S. Des. Pat. 131671

KONO MFG. CO. Woodside, N. Y.

K O N O P T I C S

AMERICAN ACADEMY OF OPTOMETRY

Dr. Arthur P. Wheelock, *President*
Des Moines, Iowa

Dr. Curtis R. Wells, *Vice-President*
Boston, Mass.

Dr. J. Fred Andreae, *Secretary*
Baltimore, Md.

EXECUTIVE COUNCIL

Dr. Arthur P. Wheelock, *Chairman*
Des Moines, Iowa

Dr. Curtis R. Wells, *Vice-Chairman*
Boston, Mass.

Dr. J. Fred Andreae, *Secretary*
Baltimore, Md.

Dr. W. Edward Dewey
Battle Creek, Mich.

Dr. Wm. Greenspoon
Bluefield, W. Va.

Dr. Harold Fisher
New York, N. Y.

Dr. Glenn Winslow
Los Angeles, Calif.

Office: American Academy of Optometry: 901-903 Lexington Bldg., Baltimore, Md.

The AMERICAN JOURNAL OF OPTOMETRY AND ARCHIVES OF THE AMERICAN ACADEMY OF OPTOMETRY serves as the official publication of the American Academy of Optometry. It is published monthly by the American Journal of Optometry Publishing Association under the editorial supervision of the American Academy of Optometry.

Publication Office: 1501-1504 Foshay Tower, 821 Marquette Ave., Minneapolis, Minn.

AMERICAN JOURNAL OF OPTOMETRY
and ARCHIVES *of*
AMERICAN ACADEMY OF OPTOMETRY

Vol. 19 — No. 4

CONTENTS

Page

ORIGINAL PAPERS

The Effect of Adaptation Upon Visual Efficiency in Illumination Studies. Miles A. Tinker 143

The Influence of Orthoptic Training on Reading Ability. Part II. The Problem, Study and Conclusions. Henry B. Peters 152

EDITORIALS

The Sheard Foundation's Ambitious Program. R. M. Hall 177

TRANSACTIONS OF THE ACADEMY by J. Fred Andreae 187

ABSTRACTS 190

It's Overtime for

Eyes, Too . . .

How good can you make them?

All out for Victory calls for twenty-four-hour days, seven-day weeks, maximum production from every worker. From your training and experience, you know better than anyone what this means in terms of the demands on visual efficiency. Your duty to America is to help keep eyesight keen and tireless. We ask again, "For the great task on hand, are any but the best optical products good enough?" We recommend to you Orthogon,* Panoptik,* Loxit, optical products designed and built to honor Bausch & Lomb's name—and yours.

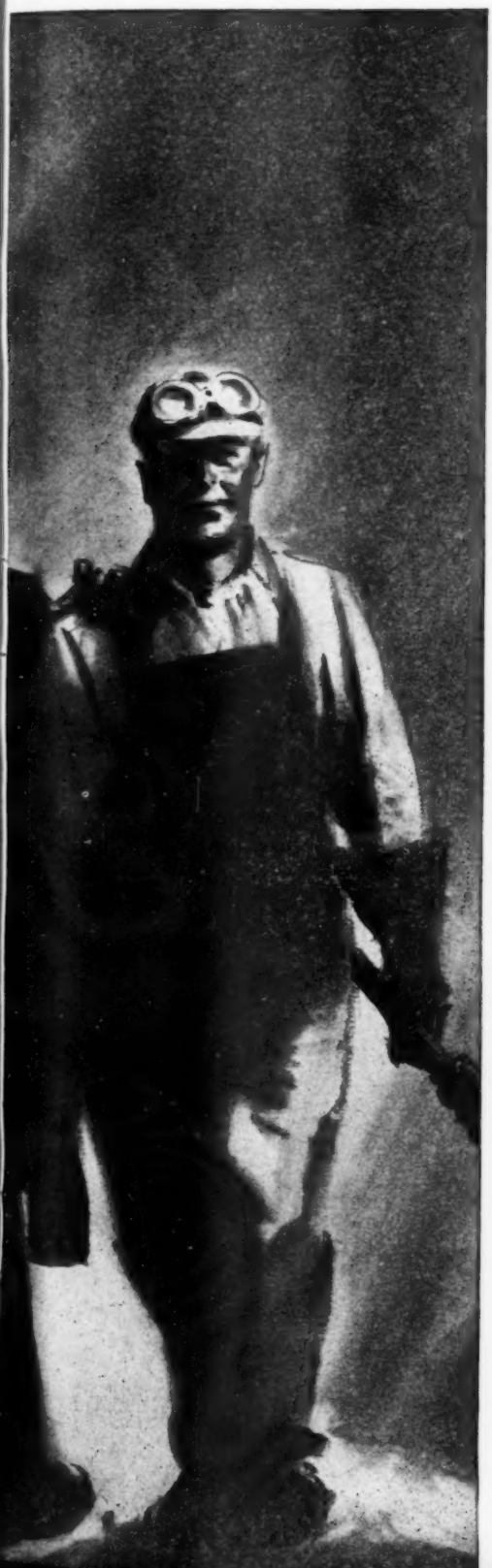
******In Soft-Lite, too*

Bausch & Lomb

OPTICAL COMPANY • ESTABLISHED 1853

The Nation's Man Power

is Lined Up for War



Young men will see most of the actual combat. But presbyopes must fight too. Older men will fight in the vital battle for increased production of war materials.

One of your jobs is to give men over 40 comfortable and efficient vision. Fortunately you are ready. Ready because, in the past, you have studied their needs and have been thinking of ways and means to give them flexible vision.

We are ready too. Ready with Ful-Vue Bifocals, product of your study and thinking—and ours. We are proud of the many Ful-Vue Bifocal advantages. Proud of the way they translate the full measure of your skill. And we like to think that even more important is the thinking they typify—the American way of thinking that has helped make American vision the most efficient in the world.

FUL-VUE BIFOCALS

Patented

1. *Are Tillyer Lenses*
2. *Have Angled Segment Tops*
3. *Have Exclusive Wide Field Design*
4. *Eliminate Perceptible Displacement*
5. *Have Curved Segment Tops*
6. *Have a Feather Edge at Bottom*
7. *Are Color-Free Nokrome*
8. *Have Ophthalmic Lens Surface of Unsurpassed Quality.*

American Optical
COMPANY

Public Relations...

a plan for the future of your practice

Today the subject of Public Relations is one with which every professional man should be familiar . . . because of its influence upon the success of every practice.

How can Public Relations help promote *your* practice . . . increase your income . . . build a sound foundation for your future prosperity?

You'll find the answers to these questions, and more, in the 1942 Soft-Lite Presentation . . . just as you'll find hard-hitting Public Relations activity, sponsored for you, in the Soft-Lite National Educational Program.

Ask your Riggs Representative. He'll gladly show you his copy of the new Soft-Lite Portfolio, which will give you a better understanding of Public Relations and how you can use it to advantage in your practice.

Riggs Optical Company

Distributors of Soft-Lite Lenses

General Offices: Chicago and San Francisco; Branches in Principal Western and Mid-Western Cities

AMERICAN JOURNAL OF OPTOMETRY
and ARCHIVES *of*
AMERICAN ACADEMY OF OPTOMETRY

Vol. 19 APRIL, 1942 No. 4

THE EFFECT OF ADAPTATION UPON VISUAL EFFICIENCY IN ILLUMINATION STUDIES*

Miles A. Tinker, Ph.D.
University of Minnesota
Minneapolis, Minn.

It is well known that the eyes readily adapt themselves so that effective seeing is possible at different levels of illumination intensity. The range of these intensities under which adequate discrimination of details is possible extends from a few to thousands of foot-candles. This adaptation process may occur either to a dimmer or to a brighter light. That is, if the visual mechanism has been adapted to a light of a given intensity, a change to either a dimmer or to a brighter illumination results in an adaptation to the new level of brightness.

The adaptation process is retinal in nature. Hecht (1) has shown that there are two phases to adaptation. One is concerned with cone vision and the other with rod vision. Since, in this report, we are interested in foveal discrimination, only adaptation for cone vision will be considered.

Adaptation to the point where retinal sensitivity becomes relatively constant takes time whether the illumination intensity is increased or decreased. As Luckiesh and Moss (6) indicate, the lag in adaptation in terms of variation in visual efficiency is greater in shifting from a higher to a lower brightness than when changing from a dim to a brighter light. Foveal adaptation to a change in illumination brightness is very rapid at first and then more gradual. Although most of the change in foveal retinal sensitivity occurs during the first three minutes slight changes continue for about ten minutes (1).

*Grateful acknowledgment is given to the Graduate School, University of Minnesota for a research grant to finance the studies which form the basis of this report. Submitted on December 19, 1941, for publication in the April, 1942, issue of the AMERICAN JOURNAL OF OPTOMETRY and ARCHIVES OF AMERICAN ACADEMY OF OPTOMETRY.

The facts of foveal retinal adaptation have a practical bearing upon visual efficiency in everyday working situations. Luckiesh and Moss (6) cite an experiment to illustrate the effect upon proficiency when the subject alternates his fixation between fields of two different brightnesses. The subject was required to discriminate a letter upon each field before shifting to the other. Most of the decrease in efficiency was found to be due to the necessity for continual re-adaptation. They also point out that "experience in performing critical tasks, such as reading, establishes the undesirability of high brightness ratios between the central and peripheral fields." Thus the marked brightness contrast between white paper or cards on the one hand and black or very dark desks, typewriters, etc., on the other is undesirable. This is true not only in terms of visual fatigue and reduced visual efficiency but also because of the psychological factors of annoyance and distraction to the subject. Another situation in which speed of adaptation raises the problem of critical seeing is night driving. This is due to the rapid change in brightness to which the eyes are exposed on meeting another car.

Application to Studies on Reading

When one is studying the relation of intensity level to efficiency in reading, or is determining the intensity of light preferred for reading, the subject is exposed to various intensities of illumination. In most experiments the tendency has been to ignore adaptation of the eye as a variable. Whether this was done because the investigator considered that the period of adaptation was so short that it merited no consideration, or whether the problem was not sensed is not known. In any case there has been no mention of the matter in most instances.

It is possible that lag in retinal adaptation at the fovea does play a role in illumination studies and therefore should be controlled. To test this hypothesis, two types of experiments were completed. They will be described in order.

In the first experiment the effect of illumination intensities upon speed of perception in reading[1] was investigated when (a) the eyes had only two minutes to adapt to the brightness of light used, and (b) when the eyes had been adapted for fifteen minutes to each level of brightness. The light of illumination employed were 0.1, 0.7, 3.1, 10.3, 17.4 and 53.3 foot-candles (measured with a Macbeth illuminometer).

[1]For the complete details of this report see Tinker (8).

The subject worked in a cubicle with gray walls. Light, coming through the ceiling, was uniformly distributed over the working surface. The printed material to be read was maintained at fourteen inches from the reader's eyes. Six groups of 82 university sophomores each served as subjects when two minutes for visual adaptation were employed. When the adaptation period was fifteen minutes, there were 72 readers in each of the six groups. Subjects were measured individually. Each subject read Form A of the Chapman-Cook Speed of Reading Test under 10.3 foot-candles of light as a standard. Form B of the reading test was then read under one of the intensities listed above. Comparison of the results will reveal reading performance under each level of light intensity in comparison with the standard. The results in Group IV will show to what extent Forms A and B of the reading test are equivalent since there the two forms were read under the same intensity (10.3 foot-candles). In the testing, succeeding subjects were rotated from one experimental condition to another so that at any stage of the experiment the same number of subjects had observed under each intensity of light.

TABLE I

Effect of Illumination Intensities Upon Speed of Perception in Reading*
(Period of Adaptation=Two Minutes.)

NOTE: Differences listed are minus when mean on Form B of reading test was less than mean on Form A. Test material was printed in 10 point type on egg-shell paper stock. There were 82 readers in each group.

Group	Foot-Candles Compared	Difference Paragraphs	Difference Per Cent	Critical Ratio
I	10.3 with 0.1	—4.91	—28.81	21.94
II	10.3 with 0.7	—1.38	— 8.09	8.45
III	10.3 with 3.1	— .77	— 4.05	4.99
IV	10.3 with 10.3	— .12	— .72	0.71
V	10.3 with 17.4	— .08	— .47	0.23
VI	10.3 with 53.3	— .11	— .64	0.62

The results for reading with two minutes of adaptation to each intensity employed are given in Table I. The differences are in terms of paragraphs of 30 words each. Note that for Group IV, the control group, there is only a chance difference. This is shown by the critical ratio of 0.71 which was obtained by dividing the difference by probable error of the difference. To be a significant difference the critical ratio should be 4.00 or larger. When Form A and B are read under exactly the same illumination, therefore, the two test forms are equivalent in

*Adapted from Tinker (8).

difficulty. The differences in the other comparisons, therefore, may be evaluated at face value without corrections. In Group I, 4.91 fewer paragraphs (28.81 per cent) were read under 0.1 foot-candles than under 10.3 foot-candles. The probability that this is a real difference is very high. In other words, if the experiment were repeated, one would be highly confident that the material would be read slower under the 0.1 foot-candle intensity. Also in Groups II and III we find similar trends. Under 0.7 foot-candles there is an 8.09 per cent and under 3.1 foot-candles a 4.05 per cent retardation in comparison with the 10.3 foot-candles. In both cases the critical ratios indicate highly stable differences. But in Groups V and VI no significant changes occur. The differences are less than 1 per cent. The critical ratios indicate that they are merely chance differences. Thus there is neither loss nor improvement when reading under 17.4 and under 53.3 foot-candles in comparison with 10.3 foot-candles. In general, the data indicate that, with the two minute period of adaptation to the illumination brightness used, speed of perception in reading increases with increase in foot-candle level up to about 10 foot-candles but not beyond that. Further increases in intensity of light had no effect on the speed of perception.

TABLE II

Effect of Illumination Intensities Upon Speed of Perception in Reading*
(Period of Adaptation=Fifteen Minutes.)

NOTE: See note in Table I. There were 72 readers in each group.

Group	Foot-Candles Compared	Difference		Critical Ratio
		Paragraphs	Per Cent	
I	10.3 with 0.1	—1.65	—8.83	9.54
II	10.3 with 0.7	— .88	—4.74	4.86
III	10.3 with 3.1	— .10	— .56	0.55
IV	10.3 with 10.3	+ .15	+ .82	1.08
V	10.3 with 17.4	— .25	—1.36	1.59
VI	10.3 with 53.3	+ .13	+ .69	0.74

The data, when a 15 minute period of adaptation was employed, are shown in Table II. Here all experimental conditions were the same as described above except that instead of adapting the subjects' eyes for two minutes, they were adapted for fifteen minutes to each illumination level. Although adaptation does progress very rapidly during the first two minutes, it is appreciable for a longer period. We wish to discover whether the longer adaptation period affects the results in a practical situa-

*Adapted from Tinker (8).

tion involving speed of perception in reading. Presumably any variation in trend of results in Table II in comparison with results in Table I is due to the difference in duration of visual adaptation, i.e., fifteen minutes versus two minutes. Inspection of the data for Group IV reveals equivalence of Forms A and B of the reading test. Consequently no correction of scores need be made in the other groups. In Groups I and II, speed of perception is significantly slower under 0.1 and 0.7 foot-candles than under 10.3 foot-candles. But under 3.1 foot-candles (Group III) speed of perception in reading is the same as under 10.3 foot-candles. The critical ratio indicates approximately chance variation. Likewise under 17.4 and 53.3 foot-candles the performance deviates only by an insignificant amount from speed of perception under 10.3 foot-candles. The trend in the data reveals, therefore, that speed of perception in reading increases from 0.1 to 3.1 foot-candles, but no farther when the illumination intensity is raised to various levels above 3.1 foot-candles. It appears that when the eyes are adequately adapted to the light intensity under which they are to work, the critical level for effective perception of print is approximately 3 foot-candles. This finding is to be contrasted with the results obtained when the eye was adapted for only two minutes. In the latter, the critical level appeared at about 10 foot-candles.* These contrasting results emphasize the importance of employing adequate visual adaptation to the light intensity under which the eyes are to work when studying the effects of illumination intensity upon proficiency of visual work. Otherwise there can be no assurance that the findings are valid since variation in the results thus obtained may merely reflect inadequate visual adaptation.

The other problem to be considered concerns the effect of visual adaptation upon intensity of light preferred for reading. But first let us examine earlier studies in this field. Under favorable conditions of light distribution and with general illumination of the test room, Luckiesh, Taylor and Sinden (2) found that on the average readers preferred 5.3 foot-candles for reading large type (11 and 12 point) and from 10.6 to 16.1 foot-candles for reading medium sized type (9 point). Also when 30 foot-candles were available only 17.4 were chosen for reading 9 point type on a gray paper which furnished poor brightness contrast between type and paper. In another study Luckiesh and Taylor (3)

*It should not be concluded that the critical level is to be prescribed as adequate for visual work in reading. There should be, of course, a margin of safety which would place the recommended intensity higher. See M. A. Tinker (7).

obtained preferences of light intensity for reading 9 point type. With up to 8 foot-candles available, the readers chose 4.2; with up to 30 available, 10.6; with 45, 16.1; with 65, 23.2; and with 100, 35.8. In a more recent investigation Luckiesh and Moss (4) asked 82 readers to select a light intensity solely on the basis of visual comfort afforded by the illumination. Up to 1,000 foot-candles were available. The median intensity chosen was 50 foot-candles although the average value was close to 100 due to one subject selecting 500 and another 1,000. In a non-scientific observation, Luckiesh (5) noted that a large number of observers preferred on the average 370 foot-candles of light for comfortable reading of a telephone directory. The illegible directory print was viewed through a small door in a black box.

In none of these experiments on intensity of light preferred for comfortable vision was adaptation of the eyes controlled. The fact that the higher intensities were chosen when the eyes were exposed to a greater range of intensities suggests that visual adaptation is playing a role in the selections. To test this hypothesis the following experiment was performed. The specific purpose was to measure the degree to which the illumination intensity chosen for comfortable reading is determined by the illumination level to which the eye is adapted.[2]

The investigation was carried out in a special room fitted with Pittsburgh Permaflector luminaries which furnished indirect illumination. The range of light intensity available at the working surface was from approximately 1 to 100 foot-candles. The subjects were 144 university students who served for two sessions of 50 minutes each.

The experiment was planned to discover what intensity of light a subject would choose for ease and comfort in reading after the eyes were adapted to a certain standard level of illumination. At one experimental period this standard level was 8 foot-candles; at the other period, 52 foot-candles. One-half of the readers began with 8 foot-candles; the other half with the 52 foot-candles. The subjects observed one at a time. When a subject arrived at the laboratory, he spent 15 minutes under the standard illumination. The reading material used was printed in 11 point type with 2 point leading on a good quality of rough surfaced book paper.

At the end of the adaptation period the subject was asked to choose which of two lights he preferred for ease and comfort in reading. One

[2]For details of this experiment see Tinker (9).

was the standard to which he had been adapted. The eyes were readapted for four minutes before going on to the next choice. The 8 foot-candle light was compared with 1, 2, 3, 5, 12, 18, 26, and 41 foot-candles taken in a random order. In a similar manner the 52 foot-candle standard was compared with 18, 30, 41, 46, 59, 62, 71, and 100 foot-candles. Thus each reader made eight choices under each of the two conditions of adaptation. Illumination intensities were checked daily with a recently calibrated General Electric Foot-Candle Meter.

Since the standard was compared with each of the eight other intensities, it was necessary to divide the frequency of choice for the 8 foot-candles and for the 52 foot-candles by 8 to make these figures comparable to the others in the computed data. The results, showing these adjusted data, are listed in Table III. In the top section of the table are the results when the subjects' eyes were adapted to 8 foot-candles, and in the bottom section the results when adapted to 52 foot-candles.

TABLE III

Effect of Visual Adaptation Upon Intensity of Light Preferred for Reading Eleven Point Type*

Data when adapted to 8 foot-candles

Foot-candles Compared:	1	2	3	5	8	12	18	26	41
Frequency of Choices :	0	5	6	18	107	98	70	57	48

Data when adapted to 52 foot-candles

Foot-candles Compared:	18	30	41	46	52	59	62	71	100
Frequency of Choices:	25	37	53	65	98	54	55	42	35

It is obvious that the intensity to which the readers were adapted plays a dominant role in the preferences. When adapted to 8 foot-candles, the most frequent choice is 8 foot-candles. The three most popular intensities are 8, 12, and 18 foot-candles with the median for the whole series at 12.

The trend is similar but even more striking when the readers were adapted to 52 foot-candles. There is a concentration of preferences about the 52 foot-candle intensity which was most preferred and which also was the median for the whole series. Thus in both series, the intensity most frequently chosen for ease and comfort in reading was the one to which the eyes had been adapted. Furthermore, even though some readers preferred either brighter or dimmer illumination, a large majority of the choices clustered close to the light to which the eyes had been adapted.

*Adapted from Tinker (9).

It appears that the brightness of illumination to which the eyes are adapted determines to a large degree the intensity which will be chosen for ease and comfort in reading ordinary book type (11 point). The results from experiments in which visual adaptation has not been controlled, therefore, can have little meaning. With proper control of adaptation, one can obtain a preference for almost any desired intensity of light. In the earlier experiments, cited above, considerable variation in preferred intensities occurred. Probably this was due to variation in visual adaptation as the subjects were exposed to a range of intensities which differed from one situation to another. It is not surprising, therefore, that preferred light intensities frequently fail to agree with results from experiments to determine the intensity of light needed for effective visual work.

These results indicate that preference for light intensity cannot be used as a satisfactory measure of effective illumination. Consequently data of this kind should not be employed as a basis for recommended standards of illumination.

The data presented in this report show that lag in visual adaptation must be considered in practical experiments concerned with the effect of illumination intensity upon visual efficiency. It has been demonstrated that the state of visual adaptation (1) affects performance in speed of visual perception and (2) plays a dominant role in determining brightness of light preferred for ease and comfort in reading. In all illumination studies concerned with visual efficiency, therefore, the eyes should be adequately adapted to the intensity level used.

Summary

1. When the illumination to which the eyes are exposed is changed to either a brighter or to a dimmer light, an appreciable time elapses until retinal sensitivity becomes relatively constant. The question is raised as to whether this period of adaptation has a practical bearing upon measuring the relation of illumination to visual efficiency.
2. Speed of visual perception under different levels of illumination intensity was determined under two conditions: (a) 2 minutes adaptation to illumination used, and (b) 15 minutes adaptation to illumination used.
3. At certain levels of brightness, the subjects were less efficient in speed of perception with 2 minutes than with 15 minutes visual adaptation.

4. The effect of visual adaptation upon illumination intensity preferred for reading was determined.
5. It was found that, when a reader is adapted to a specific intensity of light, he tends to prefer that intensity or one close to it for ease and comfort in reading.
6. Since the state of visual adaptation does affect results in illumination studies, the eyes should be adequately adapted to the level of brightness employed.

REFERENCES

1. Hecht, S. The nature of the photoreceptor process. Chapter 14 in C. Murchison, A Handbook of General Experimental Psychology. Worcester: Clark University Press, 1934, 704-828.
2. Luckiesh, M., Taylor, A. H., and Sinden, R. H. Data pertaining to visual discrimination and desired illumination intensities. J. Franklin Institute, 1921, 192, 757-772.
3. Luckiesh, M., and Taylor, A. H. Illumination intensities chosen for reading. Trans. I. E. S., 1922, 17, 269-272.
4. Luckiesh, M., and Moss, F. K. The new science of lighting. Lighting Research Laboratory, General Electric Company, Cleveland, 1934.
5. Luckiesh, M. The eyes should have it. (An interview by C. Brooks.) Good Housekeeping, Nov., 1934, 88-89; 201-202.
6. Luckiesh, M., and Moss, F. K. The science of seeing. New York, D. Van Nostrand Co., 1937.
7. Tinker, M. A. Illumination standards for efficient work in the home, school, office and factory. Amer. J. Optom., 1938, 15, 198-207.
8. Tinker, M. A. The effect of illumination intensities upon speed of perception and upon fatigue in reading. J. Educ. Psychol., 1939, 30, 561-571.
9. Tinker, M. A. Effect of visual adaptation upon intensity of light preferred for reading. Amer. J. Psychol., 1941, 54, 559-563.

THE INFLUENCE OF ORTHOPTIC TRAINING ON READING ABILITY*

PART II. THE PROBLEM, STUDY AND CONCLUSIONS

Henry B. Peters, M.A., Opt. D.
Chico, California

The Problem

The purpose of this investigation is to study the relation between visual factors and reading by the ORTHOPTIC METHOD. The major consideration is an investigation of the relation between orthoptic training and changes in reading ability. The reading ability and changes in it are measured by standardized reading tests. A complementary consideration on which data are obtained is the investigation of visual changes as measured by standard optometric techniques accompanying the orthoptic training.

The basic hypothesis of this investigation is that reading is a total process involving the whole individual in an active coordination to secure meaning from printed or written symbols. It is not merely a matter of central processes nor is it dependent entirely upon the visual apparatus; but conditions of mental maturity, background of experience, emotional stability, health, interests, organic and physiological maturity, light contrast of material, size of type, etc., all have an influence and may, under certain circumstances, act as limiting factors in the reading. The listing is by no means complete, nor does it give any cue to the inter-relation of these factors but enough are presented to emphasize the point that reading is a whole process involving many factors and that limitations may occur at any point.

---

*Research done at the University of Nebraska, under the direction of Dr. D. A. Worchester, Department of Educational Psychology and Measurements, with a research fellowship from the American Research Council of Optometry, and equipment loaned from the American Optical Company. Submitted on December 6, 1941, for publication in the April, 1942, issue of the AMERICAN JOURNAL OF OPTOMETRY AND ARCHIVES OF AMERICAN ACADEMY OF OPTOMETRY. Part I, "Introduction and Review of Literature," appeared in the March, 1942, issue.

One of these points is the physical mechanism, for it is here that the light passes into the body to stimulate the nerve endings which transform light energy to nerve energy and relay it to the brain centers. Not only the focusing of an image on the retina but the accurate coordination and integration of the action of psycho-physiological factors in the binocular organism are necessary to full visual functioning that is required in maximum reading efficiency. Versions, ductions, fusional and accommodative reserves, fixation ability, suppressions, and acuity, as well as the static and dynamic refractive conditions must be considered in any rating of visual efficiency.

A Brief Description of the Plan of the Experiment

This investigation is an experiment with college freshmen as subjects. The study was divided into two parts, hereinafter referred to as Experiment A and Experiment B. The former was conducted during the first semester 1938-39 with a large group of students who made low scores on the standardized psychological and reading tests used in this study. These students were drawn from the course Education 30 (Introduction to Teaching) required of all freshmen entering the Teachers College of the University of Nebraska. In Experiment A the students selected were divided into three groups, A, B, and C, on the basis of pairings on reading and psychological tests. Group A was given orthoptic training for a period of six weeks in three half-hour sessions per week and then was given pedagogical training in one two-hour session per week for three weeks. Group B was given pedagogical training for six weeks and then orthoptic training for three weeks in training periods similar to Group A. Both of these groups, A and B, were photographed each week with the ophthalmograph (eye-movement camera). Group C was given pedagogical training during the entire semester and had eye-movement film records taken only at the beginning and end of the semester. Reading tests were given at the beginning of the experiment, again in the middle, and at the end. A visual examination was given to students in these three groups, and Group A was given a second one so that the students in this group were tested before and after the orthoptic training was administrated. The orthoptic training consisted of exercises on the Binocular Synchronizer and the Squint Korrector for each individual during each training session. The pedagogical training consisted in motivated reading and development of techniques of reading as described later in this chapter.

In Experiment B the subjects were a random sample of freshman students registered in Education 30 during the second semester of 1938-39. The students selected were divided into three groups, E, F and G, on the basis of the kind of orthoptic training received. Three different instruments were used: each group receiving training on only two, one alone for five weeks, then another for five weeks. Various combinations of instruments were used with the different groups. All the students in these three groups were photographed with the eye-movement camera each week during the training. Reading and visual examinations were administered at the beginning, middle, and end of the experiment to those students in Groups E, F and G, while the remainder of the students in the course were given the reading and visual tests at the beginning and end of the semester only. Another group of students were given the reading tests but no reading training of any kind was administered. This group was drawn from a sophomore and junior course in experimental psychology at the University of Nebraska, Psychology 90. These students are to serve as an absolute control group since the two forms of the standardized reading tests were administered seven weeks apart and no training whatsoever was given.

The emphasis of the study is placed on the typical case-study technique. Cases were selected according to certain common characteristics. One typical case is analyzed in detail in each of these types and some variations of other subjects from this case are noted. Some group comparisons are made to note general trends and the influence of certain general factors, but no complete statistical analysis is attempted.

The Instruments Employed in This Study

The various instruments employed in this study logically divide themselves into two categories: testing instruments and training instruments. The former group includes the various paper-and-pencil tests as well as the mechanical and instrumental techniques used primarily for testing purposes. The latter group includes the orthoptic instruments used in this study.

The Test Instruments

The following is a list of the test instruments used in this study:

a. Ohio State University Psychological Tests, Revised each year under the direction of H. A. Toops, Chairman, Ohio College Association Committee on Intelligence Tests for Entrance, Ohio State University, Columbus, Ohio.

b. Chapman-Cook Speed of Reading Test, copyright 1924, by J. C. Chapman. Published by Educational Test Bureau, Inc., Minneapolis, Minn.

c. The General Reading Test by S. L. Pressey. Ohio State University, Columbus, Ohio, copyright 1935. Published by State Department of Education, Columbus, Ohio.

d. The Iowa Silent Reading Tests. Advanced Test (revised) by H. A. Greene, A. N. Jorgensen, V. H. Kelley. Published by World Book Company, Yonkers-on-Hudson, New York. Copyright 1927, 1931, by World Book Company.

e. The Minnesota Scale for the Survey of Opinions, prepared by E. A. Rundquist and R. F. Slette. Institute of Child Welfare, University of Minnesota. Copyright 1936, by the University of Minnesota Press.

f. The Ophthalmograph and Reading Cards are manufactured by the American Optical Company in their Educational Laboratories at Brownwood, Texas. For further information, address Bureau of Visual Science, American Optical Company, Southbridge, Mass.

g. Optometric Examination:

1. Brief history
2. Visual acuity with Rx and no Rx O.U., O.D., and O.S.
3. Interpupillary distance
4. Internal and external examination for pathology
5. Ophthalmometer
6. Static retinoscopy
7. Dynamic retinoscopy (40 cm.)
8. Subjective refraction and V.A.
9. Lateral and Vertical phorias
10. Lateral and Vertical ductions
11. Monocular cross cylinder
12. Positive and negative relative accommodation
13. Accommodative convergence and gradient
14. Positive and negative relative convergence
15. Positive and negative fusinal reserve
16. Amplitude of accommodation
17. Measure of existence and degree of suppression
18. Accuracy of changes in fixation (fixability)
19. Zone of perception monocularly and binocularly
20. Degree of stereopsis
21. Size, shape and relation of color fields

The instruments used in the training routine were:

1. Binocular Synchronizer
2. The Arneson Squint Korrector
3. The Helmholtz Stereoscope

The Problem and Conclusions

The purpose of this investigation is to study the relation between visual factors and reading by the OTRHOPTIC METHOD. This method is devoted entirely to the development of an efficient visual mechanism by the reduction of certain psycho-physiological limitations in the binocular organism of visual sensation and the broadening of certain functions which are connected with the act of reading. The considerations are:

1. The relation between orthoptic training and changes in reading ability. Reading ability and changes in it are measured by standardized optometric techniques.
2. The relation between orthoptic training and changes in visual

functions. Visual functions and changes in them are measured by standard optometric techniques.

The Conclusions in Relation to Reading Ability

From a careful consideration of the changes in reading ability manifested by the groups investigated and the typical cases examined, the following appear significant:

1. Orthoptic training, not supplemented by formal pedagogical training in reading, is accompanied by gains in both rate and comprehension in reading as measured by the test instruments employed in this study. The gains made by the orthoptically-trained group appear to be approximately equal to or greater than those accompanying pedagogical training alone. There is evidence to indicate that both types of training result in significant improvement.
2. Gains in reading ability accompanying orthoptic training are found not only with selected poor readers but also with a random selection of subjects. In the latter case, the gains are more noticeable.
3. The order of training, where both pedagogical and orthoptic procedures are used during a training program, is apparently of little consequence.
4. There appears to be a trend indicating that the Binocular Synchronizer is more efficient in affecting the reading ability of subjects studied than the Squint Korrector, though statistical significance cannot be attached to this conclusion.
5. Orthoptic training seems to be accompanied by greater changes in reading ability with those students whose scholastic aptitude is superior to their initial reading ability as measured in this experiment and who manifest certain functional limitations in the visual mechanism.
6. Orthoptic training seems to be accompanied by the least change in reading ability with those whose scholastic aptitude is lower than their reading ability and who manifest only slight visual limitations.
7. Subjects of high scholastic aptitude appear to make greater improvement in reading ability than subjects of low scholastic aptitude.

8. Motivation appears to be a significant factor in reading changes accompanying orthoptic training.
9. Visual deficiencies of the nature considered in this investigation appear to act as limiting factors in the development of reading ability in a significant number of cases. Large individual differences in the extent to which any visual limitation may act as a reading limitation are manifest.

The Conclusions in Relation to Visual Functions

From a careful consideration of the changes in visual functions manifested by the groups investigated and the individuals examined, the following appear significant:

1. Orthoptic training is accompanied by significant visual changes that tend toward the criteria of normality set-up.
2. The changes show a consistent trend toward the broadening of visual functions and reducing of visual limitations manifested at the start of the experiment.
3. The dispersion within the group was significantly reduced on nearly all visual measures, indicating that the group became more homogeneous.
4. There is relatively no change in the visual functions accompanying pedagogical training alone.
5. Certain functions show the influence of specific instrument training. The positive and negative fusional reserves, fixations, and the zone of recognition appear to be influenced more by the Binocular Synchronizer than by the Squint Korrector. There also appears to be a slight trend to indicate that suppressions are more quickly and completely reduced by stereoscopic training, but this trend is rather obscure.
6. Subjects of high scholastic aptitude appear to make more progress in the reduction of visual limitations by orthoptic training than do those subjects of low scholastic aptitude.
7. Motivation appears to be a significant factor in the successful elimination of limitations and broadening of visual functions by the orthoptic method.

Thus we see that the reading ability was greatly increased and the visual integration was achieved by orthoptic training. This training

expanded the functioning of the visual mechanism and allowed more complete functioning of the central or brain processes. That is, it eliminated or reduced any limitation in the reading act that might be due to faulty visual functioning.

But these group changes and generalized conclusions cover up the startling changes made by some of the students. Group analysis, at best, shows only what happens to the majority of subjects. But in actual clinical work we must consider the individual, and these individual subjects become of paramount importance.

Let us then consider several of these persons in order to see what happens to the visual and reading abilities in specific cases.

Case A: Large Change in Reading and Visual Functions

Case A is a young man student of about average scholastic aptitude for college students but of initial low ability in reading rate as measured by the tests used. The mechanics of eye movements are below normal as indicated by the number of fixations and regressions per line on the ophthalmograph. This student also possesses certain visual limitations as evidenced by the optometric examination. The subject is hypermetropic to a moderate degree, and certain of the muscular functions show restrictions in relation to the "normal findings." It was also observed that there is a partial suppression in the left eye probably associated with the hypermetropia, the muscular imbalance, or both. The change of fixation of the eyes is also very slow. The subject is wearing a correction that appears to be adequate.

The student is shown to be well-adjusted socially as compared to other college students on the Minnesota Survey of Opinions test. He was given orthoptic training on the Binocular Synchronizer and Squint Korrector as outlined in the procedure for Experiment A for a period of six weeks. The accompanying changes in reading ability as measured by weekly ophthalmographic records and the standardized paper-and-pencil reading tests show marked increases in all functions measured. The rate of reading was increased from *167 words* per minute to *600 words* per minute on the ophthalmograph and from a score of *10* to *16* on the Chapman-Cook Speed of Reading test, while the Pressey General Reading test also showed improvement. The accommodative convergence, ductions and reserves show a change toward the normal with a broadening and balancing of function. The suppression was eliminated,

the fixation ability became normal, and the zone of recognition was broadened.

After the four-weeks' pedagogical training in comprehension skills, the rate was reduced a small amount which is to be expected when the attention of the subject is directed toward comprehension.

This subject showed particular attentiveness, regular attendance, and was interested in the work. Motivation was probably high throughout the experiment.

This student is an example of a significant number of subjects whose scholastic aptitude exceeds their reading ability at the beginning of the training. It is probable that both orthoptic and pedagogical training are more effective on this group. On the basis of this and other similar cases where the scholastic aptitude is higher than the initial reading ability, it appears that other factors act as limitations on the reading ability. *In this case and a significant number of similar ones, the limiting factors were of a visual nature, and when these were removed, the reading ability greatly improved.*

Case B: Large Change in Reading With Little Change in Visual Functions

Case B is a young woman student moderately below average in scholastic aptitude as compared to other college students. Her initial reading ability, as measured by tests employed in this study, shows her to be only slightly below average in rate and comprehension. There are only very slight visual limitations as shown in the data on the case. The only visual functions that do not approach the "normal findings" are adduction and positive fusional reserve which may be considered low. The student has a greater feeling of inferiority than the average college student, but with all is reasonably well-adjusted to college life.

This case was taken from Group A of Experiment A and was given orthoptic training on the Binocular Synchronizer and Squint Korrector, as previously outlined, for a period of six weeks. The accompanying changes in reading ability, as measured by weekly ophthalmograph records and standardized paper-and-pencil tests, show marked increase in all aspects measured. The rate of reading increased from 254 words per minute to 660 words per minute; the number of fixations was reduced from 9.8 to 4.0 per line on the ophthalmograph. Increase in rate and comprehension is also noticed on the Chapman-Cook Speed

of Reading test and Pressey General Reading test. Only slight changes are noticed in the visual functions. The zone of recognition, fixation ability, suppression, and other factors remain identical with the first testing.

After four weeks of pedagogical training in comprehension skills, the rate of reading was reduced a slight amount as is to be expected when the subject's attention is directed toward comprehension.

This subject appeared to be highly motivated throughout the experiment. Her interest was keen and her attendance regular. It seems reasonable to suppose that her feeling of inferiority spurred her on to greater effort. This student is an example of a small number of students who made significant gains in reading without noticeable changes in the visual functions. On the basis of this and other similar cases, it appears probable that deficiencies in previous training account for the initial retarded reading ability. It is possible that other functions not measured may be the active ones causing this reading achievement.

Case C: Little Change in Reading With Large Change in Visual Functions

Case C is a study of a young woman student taken from the second semester experiment, Group B. Her scholastic aptitude, as measured by the Ohio Psychological test, is in the lower quartile for college freshmen. Her initial reading ability measured by the tests employed in this study shows her to be slightly below average in most regards. Certain visual limitations in muscular balances are evidenced by the phoria and accommodative convergence. A partial suppression in the left eye and limited fixation ability are also present. This student was given training on the Squint Korrector for five weeks and on the Stereoscope for five weeks as was prescribed for Group E, Experiment B. It will be noticed on the following pages that very little reading changes are evidenced, though slight gains are manifested on most tests. The visual functions, however, showed marked change toward the "normal findings." The accommodative amplitude, zone of perception and stereopsis were increased, the suppression eliminated, muscular imbalances reduced, and fixation ability became normal. This student apparently was not as well adjusted toward her family as are other college students, but her general adjustment to college life was only very slightly below average for college students, as measured by the Minnesota Survey of

Opinions test. This student evidenced mild interest and, though motivation was not high, it was slightly better-than-average in the opinion of the investigator.

In this and similar cases where the scholastic aptitude of the individual is equal to or below the reading achievement, reduction of visual limitations does not appear to greatly affect the reading ability. However, it is observed that the visual efficiency is improved, therefore, reading has been made more comfortable and more efficient for these individuals.

Case D: Little Change in Reading and Visual Functions

Case D is a young woman who appears to have relatively low confidence in the future, and her ability to cope with it. Though she does not feel any more inferior than the average college student, she does not appear to want to take a zestful part in life. Other than this, she is rather well adjusted socially as measured by the Minnesota Survey of Opinions test. She is in the lowest quartile in scholastic aptitude for college freshmen. Her initial reading ability is about average in most respects and slightly higher in rate as measured by the the test employed. The fixation-ability is not normal as might be expected from the fact that 4 prism diopters of esophoria exist. There is a small degree of hypermetropia and astigmatism present, but the other functions measured show no apparent limitations. This subject, from Group G, Experiment B, was given training on the Binocular Synchronizer for five weeks as outlined in Chapter II, and then on the stereoscope for five weeks. The changes in reading are given on the succeeding pages. Aside from the initial drop followed by an increase in rate to a slightly faster level, very little change in reading ability is noticed from the weekly ophthalmograph records. The Chapman-Cook Speed of Reading and the Iowa Silent Reading tests show no apparent changes in the functions measured by them. The Pressey General Reading test shows a drop, but it is to be remembered that previously cited data indicated that Form B is more difficult than Form A. There are practically no visual changes of any significance. The degree of stereopsis was increased from 90 to 100 per cent, but the other functions remained essentially the same.

This student participated in this experiment with the attitude of grudging acceptance of the job to be done. Motivation was rather low at all times and attendance was irregular.

It may be concluded from this and the few similar cases where

scholastic aptitude is lower than the initial reading ability, motivation is low and where there are few visual limitations, changes in reading ability or visual functions are small.

Whether we consider the groups or study the individuals within the groups we find definite evidence of the efficacy of the Orthoptic Method. The other methods considered lead to many controversial conclusions, but it is hoped that this study will point the way to a better understanding of the role of the visual apparatus in reading. This approach is no panacea. Many other factors enter into the *whole processes* of reading. However, it is felt by the author that visual inefficiency does act in such a way as to limit the development of reading ability and when these visual limitations are removed improvement will be found in good and poor readers alike.

There yet remains to be investigated a method of differential diagnosis to determine which individuals in a group will benefit most by this type of work. Some consideration has been given to this problem in the case studies presented, but much detail needs to be filled in. It is hoped that this paper will stimulate study along this line.

The important point is, however, that in spite of the lack of static correlation, there is a very definite dynamic relationship between visual limitations and reading ability.

Note:—On pages 163-174 will be found the statistical material relating to changes in reading ability accompanying orthoptic training and pedagogical training for various groups used in this study, as well as data relating to changes in visual functions as the result of orthoptic training.

On pages 175-176 will be found the General Bibliography.

On pages 95-111 of the March, 1942, issue, will be found, Part I of this report, the "Introduction and Review of Literature."

APPENDIX—TABLES

TABLE I

CHANGES IN READING ABILITY
ACCOMPANYING ORTHOPTIC AND PEDAGOGICAL TRAINING
GROUP A, EXPERIMENT A

	1. Initial Tests September, 1938	2. Middle Tests December, 1938	3. Final Tests January, 1939	Critical Ratio M_3 and M_1	Critical Ratio M_3 and M_2
1. Number	33	33	33		
2. Chapman-Cook Speed of Reading	*Form A*	*Form A*	*Form B*		
mean	13.76	17.73	14.73	4.50	1.15
std. deviation	3.56	3.61	3.23		
range	7—25	12—24	9—24		
3. Pressey General Reading	*Form A*	*Form A*	*Form B*		
Paragraph Meaning					
mean	43.76	49.03	44.33	2.20	.23
std. deviation	10.48	8.96	9.23		
range	22—58	30—64	32—60		
Vocabulary					
mean	27.30	28.88	25.85	.75	.73
std. deviation	8.24	8.80	7.81		
range	12—55	17—56	10—44		
Outlining					
mean	39.45	47.61	42.00	2.32	.75
std. deviation	14.44	14.05	13.15		
range	5—64	20—78	15—70		
Total					
mean	109.64	126.36	112.58	2.82	.49
std. deviation	23.96	24.20	24.16		
range	61—171	80—189	68—159		
5. Ophthalmograph Records					
Fixations					
mean	9.28	6.25	6.23	9.77	9.53
std. deviation	1.47	.98	1.08		
range	5.6—11.8	4.4—8.4	4.4—9.0		
Regressions					
mean	1.92	.67	.59	6.94	7.39
std. deviation	.99	.35	.37		
range	.4—3.6	.2—1.4	00—1.2		
Comprehension					
mean	79.70	85.76	87.27	2.01	2.37
std. deviation	15.27	8.18	10.23		
range	50—100	60—100	60—100		
Rate					
mean	258.91	424.00	428.39	9.08	8.24
std. deviation	73.34	74.47	92.65		
range	145—387	286—608	293—616		

TABLE II

CHANGES IN READING ABILITY
ACCOMPANYING PEDAGOGICAL AND ORTHOPTIC TRAINING
GROUP B, EXPERIMENT A

	1. Initial Tests September, 1938	2. Middle Tests December, 1938	3. Final Tests January, 1939	Critical Ratio M_3 and M_1	Critical Ratio M_3 and M_1
1. Number	33	33	33		
2. Chapman-Cook Speed of Reading	*Form A*	*Form A*	*Form B*		
mean	14.15	18.30	16.67	4.03	2.55
std. deviation	4.29	4.06	3.78		
range	1—23	10—27	8—24		
3. Pressey General Reading					
Paragraph Meaning					
mean	44.48	46.42	48.67	.71	2.00
std. deviation	7.97	13.63	9.11		
range	28—64	14—68	36—66		
Vocabulary					
mean	29.09	30.42	29.52	.55	.23
std. deviation	8.64	10.97	6.56		
range	14—48	12—56	13—42		
Outlining					
mean	39.00	46.18	40.03	2.05	.31
std. deviation	14.62	13.81	12.06		
range	13—76	13—73	8—63		
Total					
mean	112.36	123.39	118.21	1.75	1.00
std. deviation	26.71	26.40	22.70		
range	27—182	77—188	66—149		
5. Ophthalmograph Records					
Fixations					
mean	9.64	6.40	6.34	5.89	6.60
std. deviation	2.51	1.92	1.43		
range	6.6—15.2	4.8—10.4	4.2—11.0		
Regressions					
mean	2.07	1.11	.57	2.74	5.30
std. deviation	1.57	1.27	.49		
range	0.0—4.2	00—5.8	00—2.0		
Comprehension					
mean	79.09	84.55	90.61	1.59	3.73
std. deviation	15.64	12.08	8.41		
range	40—100	50—100	80—100		
Rate					
mean	262.85	405.21	434.82	6.62	7.67
std. deviation	62.01	106.79	112.79		
range	169—354	226—545	258—750		

TABLE III

CHANGES IN READING ABILITY
ACCOMPANYING PEDAGOGICAL TRAINING
GROUP C, EXPERIMENT A

	1. Initial Tests September, 1938	2. Middle Tests December, 1938	3. Final Tests January, 1939	Critical Ratio M_2 and M_1	Critical Ratio M_3 and M_1
1. Number	32	32	32		
2. Chapman-Cook Speed of Reading	*Form A*	*Form A*	*Form B*		
mean	13.45	16.62	15.63	2.48	2.20
std. deviation	4.21	5.88	3.74		
range	5—23	9—28	8—26		
3. Pressey General Reading					
Paragraph Meaning					
mean	46.13	48.62	49.88	.97	1.56
std. deviation	9.65	10.77	9.58		
range	28—70	24—66	28—68		
Vocabulary					
mean	30.61	30.69	27.03	.03	1.79
std. deviation	8.87	12.82	7.04		
range	9—52	9—57	10—38		
Outlining					
mean	37.26	45.90	39.38	2.36	.62
std. deviation	14.19	15.52	13.02		
range	1—68	12—73	11—57		
Total					
mean	112.76	125.21	116.09	1.99	.60
std. deviation	21.88	27.90	22.16		
range	74—168	67—191	76—168		
5. Ophthalmograph Records					
Fixations					
mean	9.21		7.00		5.02
std. deviation	1.80		1.64		
range	6.4—12.2		4.2—11.00		
Regressions					
mean	1.79		.70		5.45
std. deviation	.98		.50		
range	.02—3.2		0.0—2.0		
Comprehension					
mean	79.70		82.81		.86
std. deviation	16.11		12.56		
range	30—100		50—100		
Rate					
mean	265.06		388.22		5.32
std. deviation	65.56		113.46		
range	121—450		214—632		

TABLE IV

CHANGES IN VISUAL FUNCTIONS ACCOMPANYING ORTHOPTIC TRAINING GROUP A, EXPERIMENT A

	Initial Test September, 1939	Final Test December, 1939
1. Number	32	32
2. Phoria		
mean	1.09	0.56
std. deviation	3.62	2.53
range	−6—12	−6—8
3. Adduction		
mean	10.0	10.5
std. deviation	2.90	1.60
range	4—16	9—16
4. Abduction		
mean	18.25	20.75
std. deviation	5.19	5.28
range	7—30	10—30
5. Negative Relative Accommodation		
mean	2.00	2.20
std. deviation	0.40	0.30
range	0.75—2.75	1.50—3.00
6. Positive Relative Accommodation		
mean	−2.94	−3.06
std. deviation	1.02	0.71
range	−0.50—5.00	−1.75—4.50
7. Accommodative Convergence		
mean	−1.63	−3.03
std. deviation	4.97	4.10
range	−14—10	−13—8
8. Positive Fusional Reserve		
mean	16.44	18.81
std. deviation	4.60	4.20
range	6—24	12—26
9. Negative Fusional Reserve		
mean	17.66	19.25
std. deviation	4.23	3.88
range	9—28	12—28
10. Suppressions		
complete	1	0
partial	24	14
alternating	6	16
none	1	2
11. Fixations		
defective	8	0
condition	12	11
normal	12	21
12. Zone of Recognition		
mean	3.47	2.50
std. deviation	1.06	0.79
range	1—5	1—4

TABLE V

CHANGES IN READING ABILITY
ACCOMPANYING PEDAGOGICAL READING TRAINING
GROUP H, EXPERIMENT B

	Initial Test February, 1939	Final Test May, 1939
1. Number	13	13
2. Chapman-Cook Speed of Reading	*Form A*	*Form B*
mean	17.60	18.76
range	8—27	7—23
3. Pressey General Reading	*Form A*	*Form B*
Paragraph Meaning		
mean	54.62	50.92
range	40—70	34—62
Vocabulary		
mean	41.92	35.69
range	28—59	20—48
Outlining		
mean	56.00	47.92
range	34—70	27—63
Total		
mean	152.64	135.31
range	118—174	94—166
4. Iowa Silent Reading	*Form A*	*Form B*
Total Comprehension		
mean	154.46	169.84
range	85—197	135—203
Rate		
mean	34.23	46.61
range	22—58	30—56
5. Ophthalmograph Records		
Fixations		
mean	8.50	6.11
range	5.4—11.6	4.2—8.2
Regressions		
mean	1.48	0.98
range	0.2—3.2	0.2—1.8
Comprehension		
mean	95.83	86.66
range	90—100	60—100
Rate		
mean	264.25	404.83
range	189—444	248—510

TABLE VI

CHANGES IN READING ABILITY
ACCOMPANYING ORTHOPTIC TRAINING
GROUP E, EXPERIMENT B

	Initial Test February, 1939	Middle Test April, 1939	Final Test May, 1939
1. Number	8	8	8
2. Chapman-Cook Speed of Reading	*Form A*	*Form A*	*Form B*
mean	14.5	16.5	16.0
range	7—19	10—23	11—21
3. Pressey General Reading	*Form A*	*Form A*	*Form B*
Paragraph Meaning			
mean	54.75	60.50	5.55
range	46—62	54—70	48—64
Vocabulary			
mean	30.00	34.37	30.37
range	7—44	20—46	22—36
Outlining			
mean	52.00	58.62	53.50
range	25—66	48—75	36—74
Total			
mean	136.75	153.50	140.62
range	80—169	127—187	116—174
4. Iowa Silent Reading	*Form A*	*Form A*	*Form B*
Total Comprehension			
mean	132.62	143.87	144.87
range	74—178	89—203	103—208
Rate			
mean	23.75	32.5	37.62
range	15—39	19—47	25—47
5. Ophthalmograph Records			
Fixations			
mean	9.62	7.60	6.12
range	0.8—12.4	5.6—10.0	5.0—7.4
Regressions			
mean	1.67	0.90	0.62
range	0.6—4.2	0.2—1.6	0.0—1.8
Comprehension			
mean	92.50	92.50	96.25
range	80—100	80—100	90—100
Rate			
mean	243.87	342.12	447.50
range	172—343	198—545	316—590

TABLE VII

CHANGES IN READING ABILITY
ACCOMPANYING ORTHOPTIC TRAINING
GROUP F, EXPERIMENT B

	Initial Test February, 1939	Middle Test April, 1939	Final Test May, 1939
1. Number	7	7	7
2. Chapman-Cook Speed of Reading	*Form A*	*Form A*	*Form B*
mean	14.57	18.57	16.42
range	10—22	14—30	14—27
3. Pressey General Reading	*Form A*	*Form A*	*Form B*
Paragraph Meaning			
mean	58.57	66.85	57.71
range	42—72	58—72	52—62
Vocabulary			
mean	36.00	38.57	35.57
range	25—43	30—47	31—40
Outlining			
mean	51.00	55.14	47.57
range	25—70	43—75	44—71
Total			
mean	148.14	160.57	150.85
range	108—188	142—194	135—169
4. Iowa Silent Reading	*Form A*	*Form A*	*Form B*
Total Comprehension			
mean	152.71	163.57	169.71
range	115—187	113—213	139—201
Rate			
mean	37.14	39.57	43.42
range	22—47	21—67	31—62
5. Ophthalmograph Records			
Fixations			
mean	8.71	7.60	5.51
range	5.0—11.8	4.6—8.2	4.6—6.6
Regressions			
mean	1.37	0.68	0.28
range	0.2—2.6	0.2—1.4	0.0—0.8
Comprehension			
mean	92.85	91.42	98.57
range	80—100	80—100	90—100
Rate			
mean	294.71	355.42	485.14
range	190—522	279—511	387—755

TABLE VIII

CHANGES IN READING ABILITY
ACCOMPANYING ORTHOPTIC TRAINING
GROUP G, EXPERIMENT B

	Initial Test February, 1939	Middle Test April, 1939	Final Test May, 1939
1. Number	8	8	8
2. Chapman-Cook Speed of Reading	*Form A*	*Form A*	*Form B*
mean	15.75	18.5	19.25
range	10—24	8—28	11—26
3. Pressey General Reading	*Form A*	*Form A*	*Form B*
Paragraph Meaning			
mean	48.25	53.63	55.00
range	34—53	36—65	48—60
Vocabulary			
mean	33.75	33.13	30.75
range	23—54	23—57	17—45
Outlining			
mean	51.25	56.13	45.13
range	20—69	36—68	33—59
Total			
mean	133.25	142.88	130.88
range	99—163	104—183	100—157
4. Iowa Silent Reading	*Form A*	*Form A*	*Form B*
Total Comprehension			
mean	141.37	154.62	155.62
range	120—179	113—182	133—181
Rate			
mean	34.62	43.25	40.87
range	24—52	34—68	31—59
5. Ophthalmograph Records			
Fixations			
mean	9.35	6.62	5.57
range	6.8—11.8	4.6—8.6	4.4—7.0
Regressions			
mean	1.45	0.47	0.27
range	0.4—2.4	0.2—1.0	0.0—1.0
Comprehension			
mean	87.50	91.25	95.0
range	60—100	80—100	90—100
Rate			
mean	245.25	359.0	468.87
range	207—316	255—632	387—571

TABLE IX

CHANGES IN VISUAL FUNCTIONS
ACCOMPANYING PEDAGOGICAL READING TRAINING
GROUP H, EXPERIMENT B*

	Initial Test February, 1939	Final Test May, 1939
1. Number	12	12
2. Phoria		
mean	1.25	1.3
range	−1—4	−½—4
3. Abduction		
mean	10.3	10.0
range	5—14	6—16
4. Adduction		
mean	18.5	18.6
range	10—30	9—28
5. Negative Relative Accommodation		
mean	2.17	2.01
range	1.50—3.00	1.25—2.75
6. Positive Relative Accommodation		
mean	−2.75	−2.51
range	−0.75—5.00	−1.00—4.00
7. Accommodative Convergence		
mean	−2.53	−2.33
range	−8—1	−6—2
8. Positive Fusional Reserve		
mean	18.1	18.0
range	11—26	10—26
9. Negative Fusional Reserve		
mean	18.75	18.83
range	8—22	10—22
10. Suppressions		
complete	0	1
partial	7	5
alternating	5	6
none	0	0
11. Fixations		
defective	0	0
condition	6	6
normal	6	6
12. Zone of Recognition		
mean	2.83	2.68
range	2—4	1—4
13. Stereopsis		
mean	95	96
range	40—100	50—100

*The items were selected for comparison on the basis of variability as determined by careful examination of the test results.

TABLE X

CHANGES IN VISUAL FUNCTIONS
ACCOMPANYING ORTHOPTIC TRAINING
GROUP E, EXPERIMENT B

	Initial Test February, 1939	Middle Test April, 1939	Final Test May, 1939
1. Number	8	8	8
2. Phoria			
mean	1.56	1.69	0.75
range	0—4½	–1—7	–½—3
3. Abduction			
mean	9.63	9.38	9.88
range	3—16	7—12	8—13
4. Adduction			
mean	20.38	20.25	22.13
range	13—30	16—30	16—28
5. Negative Relative Accommodation			
mean	2.00	2.03	2.09
range	1.50—2.50	1.75—2.25	1.75—2.25
6. Positive Relative Accommodation			
mean	–2.19	–2.50	–2.94
range	–1.00 –4.00	–1.25 –3.75	–2.00 –3.75
7. Accommodative Convergence			
mean	–2.0	–1.63	–4.13
range	–9—3	–6—6	–8—0
8. Positive Fusional Reserve			
mean	17.00	18.75	18.63
range	12—25	10—28	14—24
9. Negative Fusional Reserve			
mean	19.25	19.88	19.88
range	13—28	16—24	18—22
10. Suppressions			
complete	0	0	0
partial	4	3	0
alternating	3	4	5
none	1	1	3
11. Fixations			
defective	3	0	0
condition	3	2	1
normal	2	6	7
12. Zone of Recognition			
mean	4.25	3.25	3.13
range	3—5	2—5	2—4
13. Stereopsis			
mean	81.25	97.50	98.75
range	60—100	90—100	90—100

TABLE XI

CHANGES IN VISUAL FUNCTIONS
ACCOMPANYING ORTHOPTIC TRAINING
GROUP F, EXPERIMENT B

	Initial Test February, 1939	Middle Test April, 1939	Final Test May, 1939
1. Number	7	7	7
2. Phoria			
mean	0.57	0.29	0.07
range	−½—3	−½—2	−½—1
3. Abduction			
mean	8.00	8.14	9.00
range	5—13	5—10	8—10
4. Adduction			
mean	14.29	16.14	17.71
range	6—30	8—28	15—24
5. Negative Relative Accommodation			
mean	1.89	1.82	2.00
range	1.25—2.50	1.25—2.25	1.50—2.25
6. Positive Relative Accommodation			
mean	−2.54	−2.50	−2.79
range	−1.00 −3.50	−1.25 −3.50	−1.75 −3.50
7. Accommodative Convergence			
mean	−4.07	−4.86	−4.86
range	−11—1	−8 −2	−7 −2
8. Positive Fusional Reserve			
mean	15.57	16.43	18.57
range	6—26	7—24	14—28
9. Negative Fusional Reserve			
mean	17.43	18.29	20.57
range	8—22	14—24	14—26
10. Suppressions			
complete	0	0	0
partial	4	2	2
alternating	2	3	4
none	1	2	2
11. Fixations			
defective	2	1	0
condition	2	2	0
normal	3	4	7
12. Zone of Recognition			
mean	3.57	3.43	2.43
range	2—5	2—5	2—4
13. Stereopsis			
mean	80.00	98.57	98.57
range	60—100	90—100	90—100

TABLE XII

CHANGES IN VISUAL FUNCTIONS ACCOMPANYING ORTHOPTIC TRAINING GROUP G, EXPERIMENT B

	Initial Test February, 1939	Middle Test April, 1939	Final Test May, 1939
1. Number	8	8	8
2. Phoria			
mean	1.56	0.88	0.75
range	−1½—6	−1½—4	−1—4
3. Abduction			
mean	11.50	10.25	10.13
range	5—16	9—12	8—12
4. Adduction			
mean	17.68	22.75	22.50
range	6—29	12—30	14—30
5. Negative Relative Accommodation			
mean	2.31	2.16	2.16
range	2.00—3.50	2.00—2.50	2.00—2.25
6. Positive Relative Accommodation			
mean	−2.63	−2.72	−3.00
range	−1.50 −4.00	−2.00 −3.25	−2.50 −3.50
7. Accommodative Convergence			
mean	0.44	−2	−3.13
range	−10—3	−10—1	−7—7
8. Positive Fusional Reserve			
mean	19.0	20.50	21
range	6—30	14—26	15—28
9. Negative Fusional Reserve			
mean	18.38	18.75	19.00
range	10—26	12—24	14—24
10. Suppressions			
complete	1	0	0
partial	6	4	1
alternating	0	3	6
none	1	1	1
11. Fixations			
defective	1	0	0
condition	6	2	2
normal	1	6	6
12. Zone of Recognition			
mean	3.25	2.38	2.25
range	2—4	2—3	2—3
13. Stereopsis			
mean	76.25	88.75	88.75
range	10—100	60—100	60—100

BIBLIOGRAPHY

Analysis of the Reading Graph. Bureau of Visual Science, American Optical Company (VS-15), Southbridge, Massachusetts. Copyright 1938.

Bell, M. D., and Parkins, G. A., *Manual of the School Survey and Eye Examination.* American Research Council of Optometry, Ord, Nebraska. Copyright 1935.

Betts, E. A., "Visual Aids in Remedial Reading," *Educational Screen,* 15, April, 1936, pp. 108-110.

Betts, E. A., "A Physiological Approach to the Analysis of Reading Disability," Educational Research Bulletin, 13, September-October, 1934, pp. 135-40, 163-74.

Blake, Mabelle B., and Dearborne, Walter F., "The Improvement of Reading Habits," *Journal of Higher Education,* 6, February, 1935, pp. 83-88.

Brombach, T. A., *Analytical Interpretation of Visual Fields,* American Optical Company, Southbridge, Massachusetts. Copyright 1937, 33 pp.

Book, W. F., "The Development of Higher Orders of Perceptual Habits in Reading," *Journal of Educational Research,* 21, 1930, pp. 161-76.

Buswell, Guy T., *"Fundamental Reading Habits: A Study of Their Development,"* Supplementary Educational Monographs, 21. Chicago, University of Chicago, 1922, pp. xiv to 150.

Clark, Brant, "Photographic Measure of Accommodative Convergence," *American Academy of Optometry,* 10, 1936, pp. 120-33.

Clark, Brant, "Effect of Binocular Imbalance on the Behavior of the Eyes During Reading," *Journal of Educational Psychology,* 26, October, 1935.

Clark, Brant, "Additional Data on Binocular Imbalance and Reading," *Journal of Educational Psychology,* 27, September, 1936, pp, 473-75.

Crider, Blake, "Certain Visual Functions in Relation to Reading Disabilities," *Elementary School Journal,* 35, December, 1934, pp. 295-97.

Eames, Thomas H., "A Comparison of Ocular Characteristics of Unselected and Reading Disability Cases, *"Journal of Educational Research,* 25, 1932, pp. 211-15.

Eames, Thomas H., "Eye Defects in Reading Disability," *Eye, Ear, Nose and Throat Monthly,* 10, 1931, pp. 124-25.

Eames, Thomas H., "Improvement in Reading Following the Correction of Eye Defects of Non-Readers," *American Journal of Ophthalmology,* 17, April 1934, pp. 324-25.

Eames, Thomas H., "Ocular Conditions of 350 Poor Readers," *Journal of Educational Research,* 32, September, 1938, pp. 10-16.

Eames, Thomas H., "Frequency Study of Physical Handicaps in Reading Disability and Unselected Groups." *Journal of Educational Research,* 29, September, 1935, pp. 1-5.

Farris, L. P., "Visual Defects as Factors Influencing Achievement in Reading," California Journal of Secondary Education, 10, October, 1934, pp. 50-1.

Fendrick, Paul A., *Visual Characteristics of Poor Readers.* Teacher's College Monograph, 1935, Teachers College, Columbia University.

Garrett, Henry B., *Statistics in Psychology and Education.* Longmans, Green and Company, New York, 1937, pp. 210-14.

Gates, A. I., *The Improvement of Reading.* New York, Macmillan, 1929, 440 pp.

Gray, W. S., with cooperation of Kibbe, D.; Lucas, L.; and Miller, L. W.; *Remedial Cases in Reading: Their Diagnosis and Treatment.* Supplemental Educational Monographs, 22, 1922, Chicago, University of Chicago.

Jaques, Louis, *Fundamental Refraction and Orthoptics.* Los Angeles, Globe Printing Company, 1936. 224 pp.

Lee, R. B., "Value of Metronoscope Reading," National Elementary Principal, 18, No. 3, February, 1939, pp. 109-111.

Manual of Keystone Orthoptic Exercises. Keystone View Company, Meadville, Pennsylvania. Copyright 1935, p. 25.

Mills, Lloyd, "Eyedness and Handedness," *American Journal of Ophthalmology,* 8, December, 1925, pp. 933-41.

Morse-Peckham, Ray, "An Investigation of the Visual Efficiencies of 10,000 School Children and the Correlation of Vision and Scholarship," *American Journal of Optometry,* 13, No. 9, September, 1936.

Neal, Finley F., *Practical Optometry,* Part I Syllabus HR, University of California, Syllabus Series. University of California Press, 1935, pp. 11-38.

Parkins, G. A., *Diagnostic Procedure: The Study of Visual Efficiency.* American Research Council of Optometry, Ord, Nebraska, Copyright 1936, pp. 6-10.

Parkins, G. A., "Suppressions," *Bulletin* 11, *American Research Council of Optometry,* May 1938. Copyright 1938. Ord, Nebraska, pp. 4-7.

Pollock, M. C., and Pressey, L. C., "An Investigation of the Mechanical Habits in Reading of Good and Poor Readers," *Educational Research Bulletin.* 4, 1925, pp. 273-75.

Pressey, L. C., *A Manual of Reading Exercises for Freshman,* Ohio State University Press, Columbus, Ohio. Copyright 1928.

Robinson, Francis P., "The Role of Eye Movements in Reading with an Evaluation of Techniques for Their Improvement," *University of Iowa Studies.* Series on Aims and Progress of Research, June, 1933, pp. 3-52.

Rundquist, Edward A., and Sletts, Raymond F., *Personality in the Depression,* Minneapolis: University of Minnesota Press, 1936, p. 201.

Selzer, Charles A., *Lateral Dominance and Visual Fusion.* Harvard Monographs in Education, 12. Cambridge, Massachusetts, Harvard University.

Sisson, E. D., "Eye-Movement Training as a Means of Improving Reading Ability," *Journal of Educational Research,* 32, September, 1938, pp. 35-41.

Swanson, Donald E., and Tiffin, Joseph, "Betts' Physiological Approach to the Analysis of Reading Disability as Applied to the College Level," *Journal of Educational Research,* 29, February, 1936, pp. 433-38.

Taylor, E. A., *Controlled Reading, A Correlation of Diagnostic Teaching and Corrective Techniques.* Chicago: University of Chicago Press, 1937, 367 pp.

Tinker, Miles A., "Motor Efficiency of the Eye as a Factor in Reading," *Journal of Educational Psychology,* 29, March 1938, pp. 167-74.

Tinker, Miles A., "Use and Limitations of Eye Movements in Reading," *Psychological Review,* 40, 1933, pp. 381-87.

Tinker, Miles A., "The Role of Eye Movements in Diagnostic and Remedial Reading," *School and Society,* 39, 1934, pp. 147-48.

Tinker, Miles A., "Eye-Movements in Reading," *Journal of Educational Research,* 30, December, 1936, pp. 241-77.

Truax, M., and Pressey, L. C., "The Value of Drill in the Mechanics of Reading," *Educational Research Bulletin,* 7, 1928, pp. 310-12.

Whipple, G. M., "Eye Movements in Reading," *Education,* 33, 1913, pp. 552-58.

Witty, Paul A. (in collaboration with David Kopel), "Factors Associated with the Etiology of Reading Disability," *Journal of Educational Psychology,* 27, March, 1936, pp. 228-30.

Witty, Paul A., and Kopel, David, "Heterophoria and Reading Disability," *Journal of Educational Psychology,* 27, March, 1936, pp. 228-30.

Witty, Paul A., "Studies of Eye-Muscle Imbalance and Poor Fusion in Reading Disability," *Journal of Educational Psychology,* 27, December, 1936, pp. 663-67.

AMERICAN JOURNAL OF OPTOMETRY
and ARCHIVES *of*
AMERICAN ACADEMY OF OPTOMETRY

Established 1924

Vol. 19 APRIL, 1942 No. 4

EDITORS AND STAFF

Dr. Carel C. Koch ..... Editor and Publisher
Dr. Guy L. DuPlessis ..... Associate Editor
Dr. Clarence W. Morris ..... Associate Editor
Dr. J. Fred Andreae ..... Academy Secretary
Harry Brookins ..... Advertising and Production Manager
Lilly L. Koch ..... Circulation Manager
Publication Office: 1501-1504 Foshay Tower, 821 Marquette Ave., Minneapolis, Minn.
Academy Office: 901-903 Lexington Building, Baltimore, Maryland.

Annual Subscription, $4.00 in Advance; Canada, $4.50; Foreign, $5.00; Single Copies, 50c.

Original papers, scientific communications, clinical reports, books for review, and correspondence should be sent to the editor. Subscriptions and applications for single copies should be addressed to the circulation manager. Copy of advertisements must be sent in by the first of the month preceding their appearance. Communications with reference to advertising or other journal business should be addressed to the advertising manager. Academy correspondence should be addressed to the Secretary of the American Academy of Optometry.

Published Monthly by the
AMERICAN JOURNAL OF OPTOMETRY PUBLISHING ASSOCIATION

The American Academy of Optometry and the publishers of this journal have no objection to the reprinting, by other magazines, of any of the articles in this issue, provided such reprints are properly credited to the AMERICAN JOURNAL OF OPTOMETRY AND ARCHIVES OF AMERICAN ACADEMY OF OPTOMETRY.

THE SHEARD FOUNDATION'S AMBITIOUS PROGRAM

For many months now most optometrists have heard something of the Sheard Foundation. A brief review of how it functions, its procedures and accomplishments, what it hopes to do, and its present needs might be of interest to you.

PURPOSE

Its purpose is to provide monies to improve education and research in all matters pertaining to vision. The movement springs from optometrists themselves, who realize that if optometry is to progress in the future it must create and develop its own future through the individuals practicing the profession.

During the past three years research projects have been completed that were undertaken only as a result of the funds provided by the Foundation. Some of the papers written by Research Fellows and members of the staff of the School of Optometry, and published in the professional journals came as a direct result of the work of the Foundation.

As a result of research projects already completed, the staff at Ohio State has developed a sufficient reputation to be selected for specific research projects of the Federal Government relating to visual problems which are set up to aid the armed forces in winning the war.

GENERAL SCOPE OF THE RESEARCH PROGRAM

The research program has to be defined broadly enough to include developing, securing and planning the use of essential equipment for the operation of clinics and laboratories, and also the development of textbooks and laboratory manuals. Along with this program there is a special project of formulating and sponsoring educational conferences and short summer courses for graduate optometrists.

TEXTBOOKS IN PREPARATION

The following textbooks are in the process of development:

1. "The Image-forming Mechanism of the Eye."
2. "Physiology of the Retina and Retino-Cortical Pathways."
3. "Physiology of the Extra-ocular Muscles."
4. "Fundamentals in Optometric Theory and Practice."

These are being written primarily as texts for use by undergraduate students but will have application as hand-books for practicing optometrists.

These books will incorporate the findings of the research projects.

SOME CURRENT MAJOR RESEARCH PROJECTS

Some of the major research projects in progress are as follows:

A. *Research in Aniseikonia and Anisophoria*

1. The problem involved in this research project is to determine to what extent the measurements made with the method employing a peripheral fusion target represent measures of aniseikonia and to what extent measures of anisophoria. It is aimed to compare the results obtained by this method with other measures of aniseikonia and anisophoria, some of which involve new methods that have been developed at Ohio State University. It is also

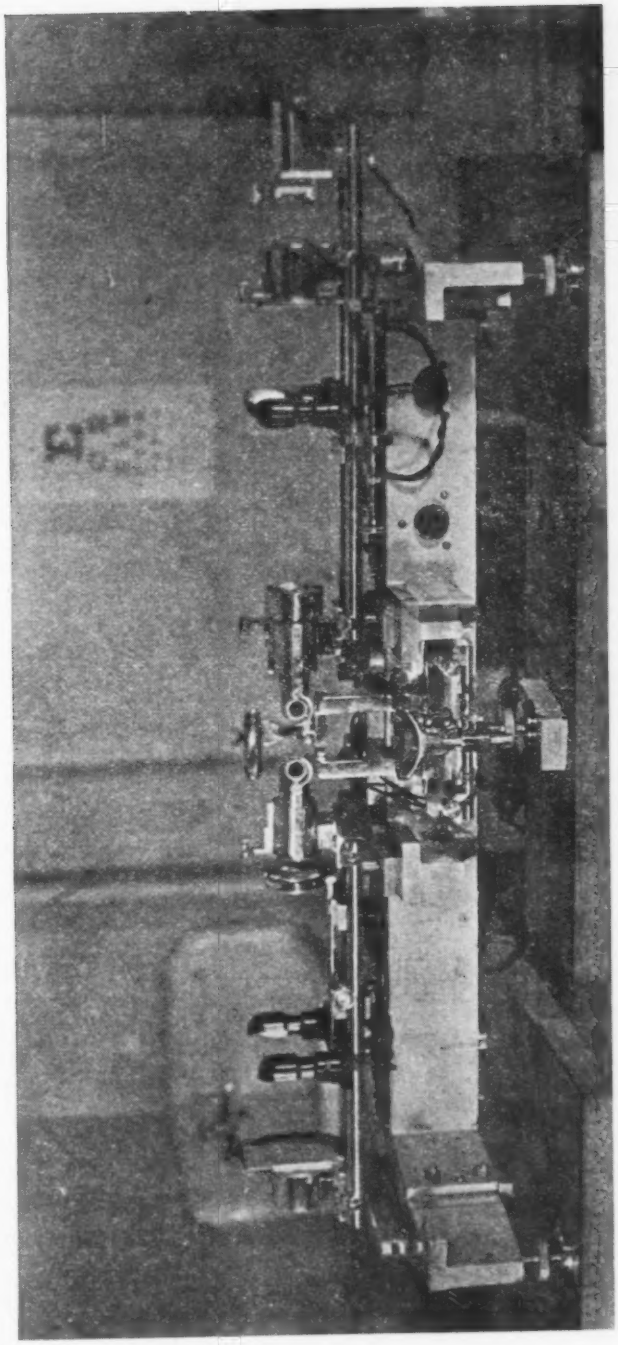


Figure 1

planned in conjunction with this study to obtain a thorough knowledge of peripheral fusion effects.

2. Another approach to the problem of the relation of aniseikonia to anisophoria would be a statistical correlation between anisometropia and aniseikonia. Theoretically, in cases of axial anisometropia lenses that correct anisometropia ought to equalize the size of the retinal images but would create a condition of artificial anisophoria. Correlation with corneal measurements is expected to help in this analysis. Measurement of aniseikonia in other meridians than just the vertical and horizontal is essential in these investigations. Fig. 1 illustrates the newly designed haploscope and some of the accessory equipment being used in these investigations.

3. Investigations in anisophoria up to the present time have been confined largely to the problem of artificial vertical imbalance at the reading level induced by anisometropia corrections. [1,2,3,4,5 and 6.]

   Attempts have been made to compensate for such effects by the use of slab-off lenses and the use of bifocal segments with unequal prismatic effects at the reading centers. An investigation is being carried on at the present time at Ohio State to determine the value of such corrections.

4. Provision has to be made for measuring angular magnification in ophthalmic lenses. Two devices have been developed for the measurement of angular magnification in lenses but some more satisfactory arrangement should be obtained. It is hoped that the Foundation will acquire eventually a universal lens measuring device similar to the dioptroeikometer, one model of which is located at Dartmouth College. Such a device permits the measurement of almost any type of optical property conceivable in an ophthalmic lens. Formulas, charts and mechanical calculating devices have been worked out for solving lens problems involving angular magnification.

5. It is planned also to investigate the use of stereo criteria for the measurement of aniseikonia and in order to complete the equipment for an investigation of this relationship, horopter and frontal plane devices in addition to the ones already on hand need to be constructed.

B. *Research in Squint*

The research program in squint has already been started and progress has been made.[7,8,9 and 10]

1. In order to develop the proper equipment to conduct this research program, a haploscope was constructed for use in mapping out localized suppression fields. It is hoped that properly controlled experiments along this line will lead to a more complete understanding of the nature of suppression.
2. A special automatic recording device has been designed for use in conjunction with the recording of changes in ocular dominance induced by voluntary control in cases of alternating suppression as well as in normal individuals.
3. Various techniques have been worked out for analyzing and treating anomalous correspondence and false fixation. An adequate set-up for photographing fundi is needed in this work.

C. *Researches Concerned with the Convergence-Accommodation Relationship*

1. An experimental analysis of the accommodation-convergence relation in terms of its fundamental variables is being made. Particular attention is being paid at the moment to the relation of psychic convergence to other forms of convergence. An effort is being made so far as possible to trace out the physiological counterparts of the different forms of convergence.[10,11,12,13,14,15,16 and 17]
2. A preliminary study has already been made of the causes of anomalies of accommodation and convergence and the correction of these anomalies through orthoptics.[18] Of special importance is the work of Hofstetter on the problem of reduced accommodative amplitude and accommodative fatigue.[19]
3. The relation of anomalies of accommodation and convergence to ocular discomfort and alleviation through the use of lenses and prisms, as well as orthoptics, is being constantly studied both in routine clinical cases and in controlled researches.

MINOR RESEARCH PROJECTS

The above types of research are the ones that currently occupy the focus of attention. The following types represent ventures in which preliminary investigation has been made and for which further plans have been mapped.

1. *Keratometry*

The work by Mote and Fry represents a start on this problem.[20,21] A device has been constructed for photographing a corneal image of a target similar to Placcido's disk in order to investigate the effect of slight departures of the cornea from the toric or spherical form. A mechanical device has been designed to analyze the data obtained with this instrument. The purpose of this data is to obtain information which can be used in explaining the discrepancy between keratometric and subjective measures of astigmatism and for investigating the basis for the various forms of scissor motion and irregular reflexes that occur in skiascopy.

A special arrangement has been devised for investigating possible changes in the curvature of the cornea induced by changes in accommodation.[22] A device that is needed is an adjustable support for a keratometer which will measure possible changes in the curvature of the cornea induced by changes in convergence and changes in the direction of fixation.

Another piece of apparatus has been constructed for the investigation of possible meridional differences in accommodation. Another phase includes the investigation of the relation of contact lenses to corneal and total astigmatism of the eye.

2. *Research in Skiametry*

Investigations have been made and reported on static and dynamic skiametry.[23,24,25,26 and 27] As a further step it is proposed to develop an atlas showing the relationship of the different forms of scissor motion and irregular reflexes to spherical aberration. A device essential to this project but not yet available is a method for photographing skiascopic shadows in the plane of the pupil. Figure 2 shows a typical arrangement of apparatus used in this type of investigation.

3. *Research in Stereopsis*

Research in stereopsis has been carried on for a number of years. The purpose of these investigations is to completely analyze all the factors contributing to individual variations in stereo-acuity and to determine the extent and the conditions under which it is susceptible to training. For several years the relation of stereopsis to accommodation and convergence has been a special object of study.[28,29]

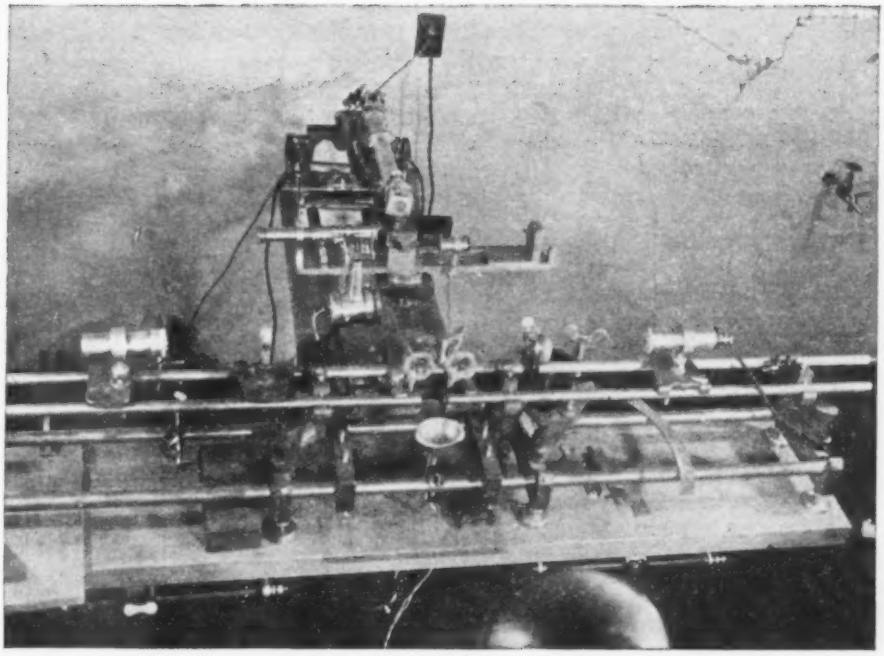


Figure 2

4. *Researches Relating to Photophobia and Glare*

In progress is the construction of an automatic recording spectrophotometer for analyzing spectral absorption of colored lenses which are to be used in testing the effects of specific types of absorptions.

5. *Investigation of Methods Used in Routine Optometric Examinations*

Several studies in addition to some of those listed above have aimed at the solution of problems which affect the routine procedure in a general examination.[30,31,32,33,34 and 35.]

6. *Research in Visual Problems in Schools and Industries and Public Health*

Looking forward to the future it is planned to spread the interests of the staff members to such problems as reading difficulties, applied problems in schools and industries, public health problems, etc. Currently several surveys are being conducted in public schools with one of the objectives being that of evaluating and improving the various methods used in this work. Characteristic of this type of research is the analysis of data obtained in a survey of the public

school at Scio[36,37] and of the Freshman class at Ohio State University.[38]

BUILDING FUND DRIVE

Because of the need not only for additional equipment, but also for larger and more adaptable quarters, the sponsors of the program decided that the first and most imperative project of the Foundation was to provide funds for a new building to house improved educational, clinical and research facilities for visual purposes. The present concentrated fund drive among all optometrists in the nation and particularly in the mid-west to raise $150,000 for this New Center of Optometry is a manifestation of that decision.

OHIO STATE CHOSEN

It was felt that Ohio State University was a very logical location for such a center. It is centrally located and affords the opportunities of a great university. The facilities already available would greatly enhance the effectiveness of the educational and research program. The willingness of the Ohio State University administrators to cooperate in furthering the field of optometry as a profession provides an excellent foundation on which to build for the future.

WHAT IT HOPES TO DO

The sponsors wish to establish an outstanding visual program. They foresee not only a thoroughgoing program of undergraduate and graduate teaching, but also a center from which will come worthwhile contributions in the fields of public relations and research.

It is proposed to provide opportunities for clinical researches as well as laboratories for controlled experiments in vision that otherwise could not be attempted in the middle west. It is aimed to establish a research program which will play a major role in completing the transformation of optometry from an art based upon rules of thumb to an applied science. One of the aims is to endow a series of research fellowships in order to make the Foundation a center for research in vision.

The educational facilities will be expanded and improved to care for a larger number of students and to better prepare them for the profession.

When the Foundation is successful in its endeavor, the program cannot help but result in improved public relations for optometry. The

thousands of students and visitors who come to the campus will have an increasing admiration and appreciation for our growing profession.

The School of Optometry as part of the University will carry weight in cultivating friendly relations with other professions and in establishing contacts with public schools and industries.

PROGRESS TO DATE

With half of Ohio still to make final reports on the success of the various local fund drives, already $48,000 has been pledged towards the new building. In addition, optometrists in neighboring states have subscribed the balance of the $55,000 that has been raised for the building alone. Add to that $14,000 which has been contributed by individuals or corporations for specific research projects and you see the Sheard Foundation's progress to date.

TIE IN WITH WAR PROGRAM

Since materials are not available for immediate construction and since it is most imperative that the war program be helped, all contributions will be used to buy United States Savings Bonds. Certificates of the bond purchase will be issued to each donor. When the time comes that it is expedient to build, the bonds will be cashed and erection of the building begun, probably at the close of the war.

It is not improbable that governmental subsidy of such building programs will be in effect at the close of the war. Consequently, it is most imperative that the cash be available to take advantage of such opportunities should they arise during the rehabilitation period subsequent to smashing the axis.

NEEDS

There is still a long way to go—$150,000 is needed for the building alone and more is needed to underwrite costs of research projects. Pledges are payable over a period of five years and have been averaging approximately $200 each. Over the five year period this would amount to $10.00 every three months, as most of the donors have elected to pay. Address all inquiries or contributions to H. W. Decker, Executive Secretary, Sheard Foundation, Room 300, Administration Building, Ohio State University, Columbus, Ohio. Your immediate assistance in the form of a check or pledge for the five year period is earnestly requested.

Richard M. Hall.

REFERENCES

1. G. A. Fry and J. C. Kehoe, An Instrument for Photographic Recording of the Position of a Pair of Lenses Mounted in Front of the Eyes, Am. J. of Opt., 17, 502-510, 1940.
2. J. C. Kehoe and G. A. Fry, An Empirical Method of Determining the Vertical Imbalance at the Reading Center of a Lens, Am. J. of Opt., 17, 543-551, 1940.
3. V. Ellerbrock and G. A. Fry, Accuracy in Determining the Reading Depth, Am. J. of Opt., 18, 258-269, 1941.
4. J. C. Kehoe and V. Ellerbrock, Measurement of Hyperphoria at the Reading Level, Am. J. of Opt., 18, 1941, 418-427.
5. V. Ellerbrock and G. A. Fry, Effects Induced by Vertical Anisometropia, to be published.
6. J. C. Kehoe, The Frequency of Vertical Anisometropia, Am. J. of Opt., 19, 1-4, 1942.
7. G. A. Fry, The Binocular Integration of Hue and Brilliance, Archives of Oph. 15, 443-456, 1936.
8. G. A. Fry, The Relation of Accommodation to the Suppression of Vision in One Eye, Am. Jour. of Oph. 19, 135-138, 1936.
9. C. S. Bridgman, An Analysis of the Binocular Vision of Individuals with Complete and Partial Section of the Corpus Callosum, Psych. Bull., 38, 589, 1941.
10. J. Zettel, Jr. and G. A. Fry, Preparation and Grading of Semi-Polished Lenses, Optometric Weekly, Nov. 13, 1941.
11. H. Hofstetter, Accommodative Convergence in the Absence of Binocular Vision, to be published.
12. G. A. Fry, Fundamental Variables in the Relationship between Accommodation and Convergence, Accepted for publication by the J. of Am. Opt. Assn.
13. G. A. Fry, Physiological Counterparts of the Different Forms of Convergence, Accepted for publication by the Journ. of the Am. Opt. Assn.
14. G. A. Fry and H. F. Haines, Tait's Analysis of the Accommodation-Convergence Relation, Am. J. of Opt., 17, 393-400, 1940.
15. H. Hofstetter, The Proximal Factor in Accommodation and Convergence, Accepted for publication by the Am. J. of Opt.
16. G. A. Fry, An Experimental Analysis of the Accommodation-Convergence Relation, Am. Journ. of Opt., 14, 402-414, 1937.
17. G. A. Fry, Further Experiments on the Accommodation-Convergence Relationship, Trans. of the Amer. Acad. of Opt., 12, 54-72, 1938.
18. H. Hofstetter, Effect of Training on the Range of Positive Relative Convergence. To be published.
19. H. Hofstetter, Factors Involved in Low Amplitude Cases. To be published.
20. H. G. Mote and G. A. Fry, The Significance of Javal's Rule, Am. J. of Opt., 16, 362-365, 1939.
21. H. G. Mote and G. A. Fry, The Relation of Keratometric Findings to the Total Astigmatism of the Eye, Am. J. of Opt., 16, 402-409, 1939.
22. H. G. Mote and G. A. Fry, An Investigation of Possible Changes in Curvature of the Cornea Induced by Changes in Accommodation. To be published.
23. G. A. Fry, Factors Contributing to the Discrepancy between Subjective and Skiascopic Determinations of the Refraction of the Eye. To be published.
24. G. A. Fry, Indirect Skiametric Methods of Determining Static Refraction. Submitted to the Canadian Journal of Optometry.
25. G. A. Fry, An Evaluation of the Various Skiametric Methods of Determining the Near Point Correction. To be published.

26. G. A. Fry, Skiametric Measurement of Convergent Accommodation, Optometric Weekly, May 9, 1940.
27. G. A. Fry, Skiametric Determination of the Limits of Relative Accommodation, Trans. Amer. Acad. of Opt., 13, 1939.
28. G. A. Fry, Measurement of Stereo-Acuity. To be published.
29. G. A. Fry and P. R. Kent, The Effects of Base-In and Base-Out Prisms on Stereo-Acuity. To be published.
30. G. A. Fry, Near Point Corrections from 14 B Findings, Optometric Weekly, Feb. 22, 1940.
31. G. A. Fry, Significance of Fused Cross Cylinder Test, Optometric Weekly, Feb. 15, 1940.
32. G. A. Fry and E. E. Reese, Effect of Fogging Lenses on Accommodation, Am. J. of Opt., 18, 9-16, 1941.
33. V. Ellerbrock and G. A. Fry, The After-Effect Induced by Vertical Divergence, Am. J. of Opt., 18, 1941, 450-454.
34. Robert Graham, A Variable Focus Lens and Its Uses, J. Opt. Soc. Am., 30, 560-563, 1940.
35. Kathryn Stone and M. L. Poole, Fundus Photography without Cycloplegics, J. Op. Soc. Am., 29, 463-465, 1939.
36. G. A. Fry, Validity of Phoria Measurements with a Stereoscope, Optometric Weekly, June 13, 1940.
37. G. A. Fry, Significance of Betts' Tests of Visual Efficiency, Optometric Weekly, July 25, 1940.
38. H. F. Haines, Visual Analysis of 2800 University Students, J. A. O. A., 8, 367-370, 1937.

TRANSACTIONS OF THE AMERICAN ACADEMY OF OPTOMETRY

by J. Fred Andreae, Secretary

A department devoted to announcements, reports, appointments, organization data, news, professional problems and ideals, as these relate to the Academy.

REPORT OF THE ADVISORY COUNCIL

The members of the Advisory Council are, Drs. R. M. Hall, E. E. Hotaling, O. J. Melvin, Carel C. Koch, and Chairman, Donald R. Paine.

Since an Advisory Council has been instituted this year for the first time in Academy history, it becomes fitting to preface the report of the committee's activities by explaining its objectives.

The function of the Advisory Council is to serve as a planning and policy screening board, each member of which is assigned one or more of the policies of service recommended in the President's address for the purpose of formulating and planning a specific course of procedure that

these policies may be put into execution. All other policies of sufficient importance which vitally affect the welfare of the Academy, and which arise from time to time, are likewise first treated by this committee.

Such tentative plans and policies, after receiving unanimous approval by the Council's entire membership, are submitted to the President and his members of the Executive Council for final approval and acceptance or veto.

SUMMARIZATION OF SPECIFIC RECOMMENDATIONS

Submitted January, 1941, to this Committee by its Chairman.

1. The establishment of a sectional congress on the West Coast (Paine). A nine-point proposal was submitted to the committee which is giving special study to the proposed plan.
2. The establishment of local Academy Chapters.
   a. Charter drafted by Dr. Hotaling.
   b. Organization work by Dr. Andreae.
   c. Policies pertaining to the maintenance of Chapters by Dr. Paine.
      (1) A tentative plan is being studied for using the Manual of Instruction as a guide around which is arranged a Supplementary and Home Reading Course in the basic aspects contained therein. (Paine)
   d. The use of Chapters as Regional Examination Centers. (Melvin)
3. Additional plans are being studied as follows:
   a. Standardized Visuals Tests for aviators and industrial workers. (Hall)
   b. Sociologic Problems of Optometry. (Koch)
      (1) The initial work on these problems by Dr. Koch consists of:
         (a) Studies published in May under caption of, "The Optometrist in the Field of Blindness Prevention."[1]
         (b) A paper presented before this body entitled, "A Plan for the Refractive Eye Care of the Indigent and Medically Indigent in Minnesota."[2]
   c. Studies Pertaining to School Visual Inspection Tests—not completed. (Paine)

---

[1]Carel C. Koch. The Individual Optometrist in the Field of Blindness Prevention. American Journal of Optometry and Archives of American Academy of Optometry. Vol. 18, No. 5, pp. 220-228. 1941.

[2]Carel C. Koch. A Plan for Refractive Eye Care for the Indigent and Medically Indigent in Minnesota. Part I and Part II. To be published.

Acknowledgment is offered for the splendid cooperation of the members of this Advisory Council with its chairman, which has made possible the accomplishments which have been herewith set forth.

Don. R. Paine.

MEMBERSHIP AND MEETING ANNOUNCEMENT

Permanent entrance requirements for Academy Fellowship, as regards case histories and practical examination, will go into effect this coming December, 1942. They are as follows: Submission of three case histories from candidates own files concisely and completely annotated as outlined in the Manual of Instruction and the passing of both the written and practical examination as outlined in the Manual.

For the information of those making application for Fellowship before the permanent requirements are in effect the following requirements govern:

CLASS I—Open to any optometrist who has been in practice more than fifteen years, and who is now practicing in an ethical and professional manner* and upon acceptance by the Board of Examiners of ten case reports from his own files concisely and completely annotated as outlined in the Manual of Instruction. To obtain "Individual Certification," the candidate may, if he so chooses, take the clinical and written examinations.

CLASS II—Open to any optometrist who has been in practice more than five years but less than fifteen, and who is now practicing in an ethical and professional manner* and upon acceptance by the Board of Examiners of five case reports from his own files concisely and completely annotated as outlined in the Manual of Instruction, and who has taken and successfully passed a practical examination. It is to be understood that the examination given by the Board is in no way comparable to individual State Board Examinations, but is in the true sense, a screening process by which the Board of Examiners will be able to determine the ability of the candidate to successfully handle the practical problems met in general routine practice.

CLASS III—Open to any optometrist who has been in practice less than five years, and who is now practicing in the prescribed manner* and upon acceptance by the Board of Examiners of three case reports from his own files concisely and completely annotated as outlined in the Manual of Instruction, and who has taken and successfully passed both the written and clinical examinations as outlined in the Manual.

Application blank will be mailed upon request to the secretary.

The Academy members voted to hold the next annual meeting in Toronto, Canada, in August, 1942. Unfortunately, the short time intervening will not permit the Program Committee to prepare the usual program, this fact, plus the present unsettled world wide conditions, has caused the Executive Council to postpone the meeting until August, 1943.

*Exclusive office practice—no display of price, merchandise, or advertising. Ground floor office accepted only where ethical physicians and dentists practice in that locality in like manner. In event you practice in a residence or ground floor office submit photographs.

ABSTRACTS

A department in which will appear abstracts of the literature of optometry, ophthalmology and applied optics. These will be classified according to the following list, although contributions to all sections will not necessarily appear in each issue.

1. Ocular Refraction.
2. Physiological Optics and Color Vision.
3. Ocular Muscles.
4. Orthoptics and Reading.
5. Anatomy, Histology and Embryology.
6. Ocular and General Pathology.
7. Ophthalmic Lenses and Material.
8. Instruments.
9. Hygiene and Illumination.
10. Applied and Physical Optics.
11. Education, Sociology and Economics.
12. Miscellaneous.

1. OCULAR REFRACTION

REPLACEMENT OF OPTICAL CENTERS IN BIFOCAL LENSES. Fry, G. A., and Ellerbrock, V. Optometric Weekly. 1941, 32, 35, 989-992.

"Assuming that the segment top falls at the margin of the lower lid, the optical center of the distance portion should fall about 3 mm. above this point. This permits the lens to be tilted forward at the top about 6 degrees which is the rule in single vision lenses. Bifocals should be tilted more in order to decrease the astigmatism in the bifocal segment, and this makes it desirable to drop the optical center of the distance portion even closer to the top of the segment. An attempt is made to clarify the problems related to 'jump' and 'displacement' in bifocals. The general conclusion is reached that the most satisfactory position for the optical center of the segment is at the reading level which in the average case lies 5 mm. below the top of the segment."—C.C.K.

TELL-TALE EYES. Kornzweig, A. L. Sight-Saving Review. 1941, 11, 3, 171-178.

This paper deals in great part with the diagnostic syndromes related to certain portions of the external inspection of the eyes. The author discusses (1) the appearance and prominence of the eyeballs. (2) The significance of a drooping lid. (3) Pupillary reactions. (4) Inequality in the size of pupils. (5) The diagnostic significance of pin-point pupils or abnormally large pupils. (6) Abnormalities in the positions of the globes of the eye as related one to the other. The article is simply written as it is intended in part at least for lay reading.—L.P.

Therminon
REG. U. S. PAT. OFF.
COMFORT AND PROTECTION

Keep 'em Fit!

Physical fitness is of top importance in the war effort . . . and of all elements in physical fitness, what is so important as good eyesight?
The refractionists of America have the front line of defense for their patients. Keep 'em fit! Give them the comfort and protection of Therminon Lenses, which transmit 92% of the useful visible light while blocking out 50% of the irritating infra-red radiations.

Ask your independent supply house representative to demonstrate all ophthalmic lenses with Thermolux . . . see what a different Therminon Lenses make.

THERMINON LENS CORPORATION
DES MOINES, IOWA

JEFFERY OPTICAL COMPANY
JEFFERY COMPLETE Rx SERVICE
Wholesalers and Manufacturers

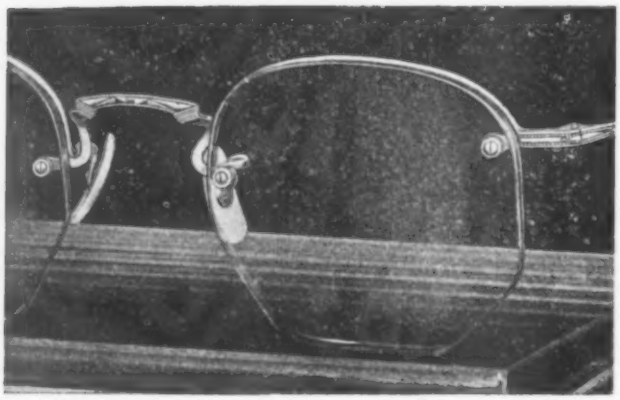
Physicians & Surgeons Bldg.
MINNEAPOLIS, MINN.

Atlantic 2469

Out of Town Rx's Returned the same day they are Received

First Quality Merchandise

A Friendly Accurate Service



GRACEFUL is the word for CUSHION - MOUNT in the popular rimway vogue. Superb construction by the makers of Cushion-Lock mountings.
Lenses are strain - free, breakage-free, wobble-free.

New

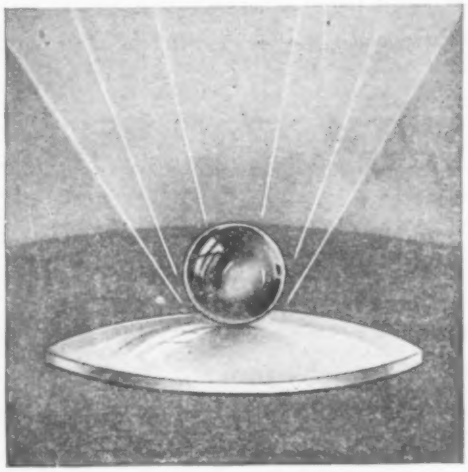
The Carlton CUSHION - MOUNT

Improved rimway construction . . . 2-point support maintains lens alignment . . . Backstraps have extra threads to hold screws . . . No metal touches glass . . . Enduring Duratex cushions protect lenses, lock screws . . . Duratex-lined washers insulate lenses from screw-heads . . . Carlton bridge in 10K gold . . . Truflo streamlined temples . . . License-free . . . ASK TO SEE CUSHION-MOUNT.

MINNESOTA OPTICAL COMPANY

MINNESOTA OPTICAL COMPANY

2928 Lyndale Ave. So. -:- MINNEAPOLIS, MINN.



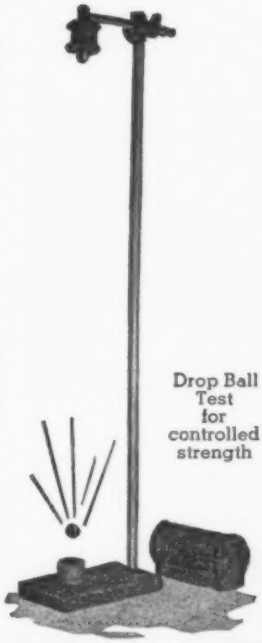
Resists breakage

Benson Fortified Ophthalmic Lenses

HARDRx Prescription lenses are for general use and are tempered for increased margin of safety against breakage.

BENSAFE Prescription Safety lenses are of heavier construction and toughened for industrial and hazardous sportswear.

Both are of highest quality and are toughened by a controlled heat treatment. Each HardRx lens is subjected to impact of 1/2" steel ball dropped one meter and Bensafe lens to 3/4" steel ball dropped one meter.



Drop Ball Test for controlled strength

N. P. BENSON OPTICAL CO. Inc.

Established 1913
Main Office: MINNEAPOLIS

Aberdeen - Bismarck - Duluth - La Crosse - Stevens Point - Eau Claire - Wausau - Albert Lea - Winona - Rapid City

The difference between *dependable performance*

. . . and uncertainty

The difference between *a product of national reputation*

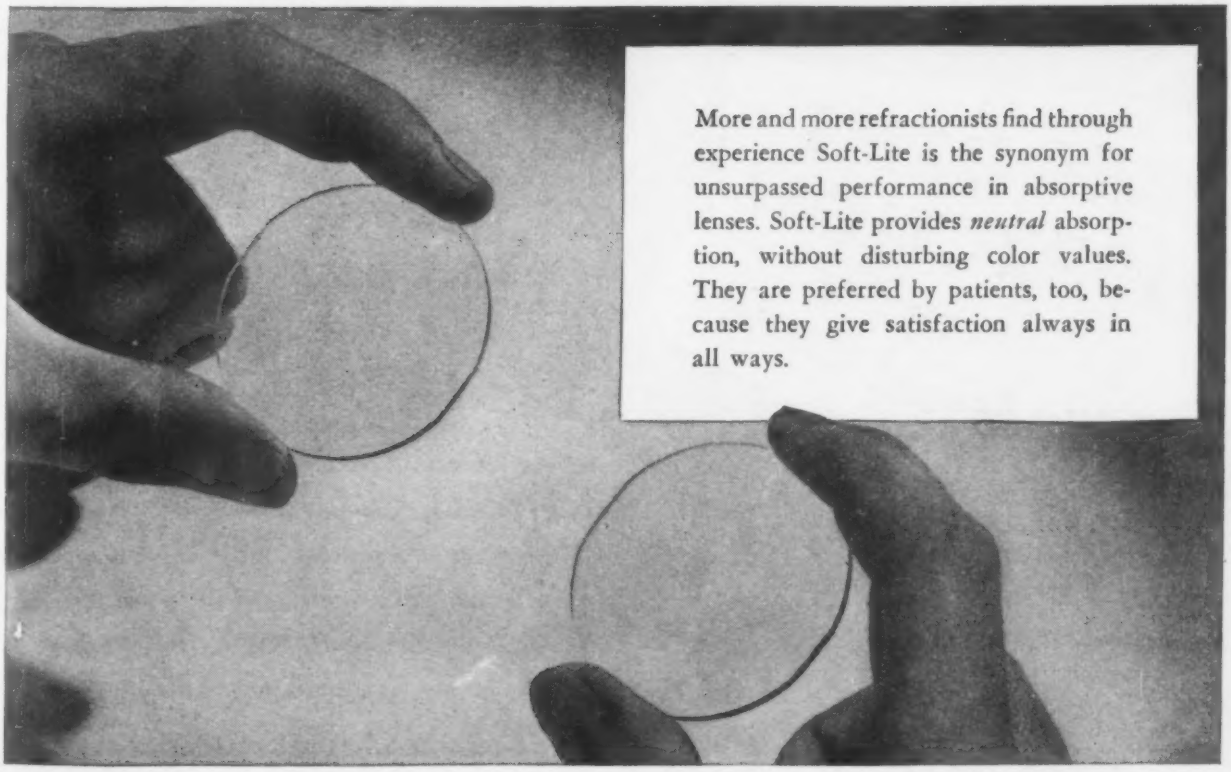
. . . and an unrecognized

The difference between *a patient who tells his friends*

. . . and one who thinks his glasses are "all right"

is *Soft-Lite Lenses*

. . . because only Soft-Lite gives Soft-Lite performance



More and more refractionists find through experience Soft-Lite is the synonym for unsurpassed performance in absorptive lenses. Soft-Lite provides *neutral* absorption, without disturbing color values. They are preferred by patients, too, because they give satisfaction always in all ways.

FREQUENT INSPECTION

insures

Quality Beyond Question

The ever-present element in all operations that produce Shuron WIDESITE Lenses is inspection "check-up." After every manufacturing step there is a precise inspection before the next operation is allowed to proceed. By the time a WIDESITE passes the last of these precision tests it's bound to be a lens of "Quality Beyond Question."

Shuron WIDESITE